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PRESIDENT

GEOLOGY, ENERGY AND MINERAL RESOURCES ASSESSMENT OF THE SONORA AREA, ARIZONA

BY

JACK CRUVER, A. WODZICKI, SUSAN K. CRUVER AND JAN KRASON

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5701 East Evans Avenue
Denver, Colorado 80222
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Prepared for:

United States Department of the Interior

BUREAU OF LAND MANAGEMENT

December 31, 1982

Geo-Scientific, Professional and Engineering Services

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Figure 1: Physiographic map of south-central Arizona showing location of Sonora, Wymola and Kitt Peak areas.

Figure 2: Paleotectonic and paleogeographic maps of Arizona showing location of the Sonora GRA.

Figure 3: Geologic, energy and mineral resources map of the Sonora area, Arizona.

Figure 4: Legend for geologic, energy and mineral resources maps.

Figure 5: Claim density map, with oil and gas leasing status, of the Sonora area, Arizona.

Figure 6: Location of oil and gas exploration holes in southern Arizona.

Figure 7: Favorability and level of confidence map for metallic mineral resources of the Sonora area, Arizona.

Figure 8: Favorability and level of confidence map for uranium resources of the Sonora area, Arizona.

Figure 9: Favorability and level of confidence map for non-metallic mineral resources of the Sonora area, Arizona.

TABLES

Table 1: Claim density records in the Wilderness Study Area, Sonora GRA.

Table 2: Geological environments of the Sonora area and associated potential mineral deposit types.

GEOLOGY, ENERGY AND MINERAL RESOURCES ASSESSMENT IN THE SONORA AREA, ARIZONA

by

Jack Cruver, Antoni Wodzicki, Susan K. Cruver and Jan Krason

Summary

The Sonora "Geological Energy and Mineral (GEM) Resources Area (GRA)" lies within Maricopa, Pinal and Gila Counties, southeastern Arizona, and contains the White Canyon (2-187) Wilderness Study Area (WSA). The GRA is largely located within the Mexican Highland section of the Basin and Range province, and lies south of the Colorado Plateau. The southwestern corner of the GRA lies in the Sonoran Desert section of the Basin and Range.

The oldest rocks within the GRA are the Pinal Schists which were deposited 1.7 to 1.68 b.y.B.P. and consist of quartz-muscovite schist, arkose and quartzite, locally with andalusite and sillimanite. These metasedimentary rocks were intruded by the Madera Diorite during the Arizonan Orogeny 1630 m.y.B.P., and by the Oracle (or Ruin) Granite between 1450 and 1400 m.y.B.P. Shallow marine deposition occurred intermittently through the upper Precambrian and Paleozoic, depositing the Precambrian Apache group and Troy Quartzite, the Cambrian Bolsa Quartzite and Abrigo Formation, the Devonian Martin Formation, the Mississippian Escabrosa Group, and Pennsylvanian Naco Limestone. There is no record of sedimentary or igneous activity until the Cretaceous, during the initial stages of the Laramide orogeny. During the Laramide orogeny, a small amount of volcanic activity occurred, but the majority of the igneous activity was related to small calc-alkaline plutons intruding the Precambrian and Paleozoic rocks. During the mid-Tertiary 40-20 m.y.B.P., a sequence of fluvial sediments and calc-alkaline volcanics were deposited in the local basins. During the Late Tertiary basalt flows were erupted, and fluvial sedimentation occurred, as did the Basin and Range tectonic disturbance.

Geological environments potentially favorable for the occurrence of mineral and/or energy resources in the GRA include Precambrian granites, Precambrian sediments, Laramide intrusive rocks (in particular where they have intruded Pinal Schists or Precambrian or Paleozoic limestone), mid-Tertiary basin-fill sediments, mid-Tertiary plutons and volcanics, and alluvium. Precambrian granites and sediments are favorable environments for uranium (at least nine uranium occurrences are within Precambrian granite). Major porphyry copper deposits are associated with Laramide intrusives in the GRA, as well as numerous hydrothermal tungsten, molybdenum, silver, gold, zinc, lead and manganese occurrences. Numerous copper, gold, silver and manganese hydrothermal deposits are present in mid-Tertiary volcanics and plutons. Two gold placer districts are present in the GRA, as well as two individual gold placer occurrences found in alluvium.

The White Canyon WSA is underlain by Precambrian Pinal Schists and Ruin (Oracle) Granite. Mid-Tertiary sediments and volcanic rocks crop out in the central region of the WSA, and cover Precambrian and Paleozoic sediments. A

Laramide quartz monzonite crops out along the eastern boundary of the WSA, and a mid-Tertiary pluton crops out in the southwestern area of the WSA. The WSA is classified as having moderate favorability for metallic deposits based on occurrences near the WSA. It is classified as having a moderate to low favorability for uranium. Source rocks are present within the area, and occurrences are found nearby in these rocks. There is a low favorability for finding non-metallic deposits within the WSA. There are no occurrences within the WSA, but there are producing deposits within the GRA. There is a low favorability for oil and gas in the WSA, based on the large amount of igneous activity in the area during the Laramide and mid-Tertiary.

Important recommendations for further work in the WSA includes:

1. Field checking for the presence of extensive hydrothermal alteration and widespread mineralization.
2. Field checking the mid-Tertiary conglomerates for eroded mineralized Precambrian and Paleozoic rocks.
3. Field checking for reductants in the mid-Tertiary sediments and volcanics.

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INTRODUCTION

Purpose and Methodology

The need for "Geological, Energy and Minerals (GEM) Resources Assessment" of "Wilderness Study Areas" (WSA) has been recognized for some time by the Bureau of Land Management (BLM). The assessment is now being performed by various contractors for the BLM.

Wilderness Study Areas, widely scattered within the Sonoran Desert and Mexican Highlands and grouped into Region 5 by the BLM, are being studied and assessed by Geoexplorers International, Inc. The present report pertains to the White Canyon WSA in southeastern Arizona which is contained in the Sonora Geological, Energy and Mineral Resources Area (GRA).

The purpose of the present study is to assess the potential for locatable, leasable and salable resources within the GRA, and specifically within each of the WSAs. This assessment has been carried out through literature study of the geology, structure and economic geology of the GRA, and a consideration of the regional paleogeographic, plate tectonic and metallogenic setting of the GRA within the southern Cordillera. Thus, the assessment is not only based on data from the GRA itself, but also on metallogenic concepts within the regional paleogeographic and plate tectonic framework.

Location and Access

The Sonora GRA is located within Maricopa, Pinal and Gila counties, southern Arizona. The GRA lies mostly within the Phoenix Resource Area of the BLM-administered Phoenix District, and partially in the Gila Resource Area of the BLM-administered Safford District. The GRA is located in the south central part of the Mesa 1:250,000 quadrangle, approximately between latitudes 33° and $33^{o}32'$ and longitudes $110^{o}52'$ and $111^{o}22'$.

INTRODUCTION

Purpose and Methodology

The need for "Geological, Energy and Minerals (GEM) Resources Assessment" of "Wilderness Study Areas" (WSA) has been recognized for some time by the Bureau of Land Management (BLM). The assessment is now being performed by various contractors for the BLM.

Wilderness Study Areas, widely scattered within the Sonoran Desert and Basin and Range Provinces and grouped into Region 5 by the BLM, are being studied and assessed by Geraghty & Miller International, Inc. The present report certains to the Water Canyon WSA in southeastern Arizona which is contained in the Sonora Geological, Energy and Mineral Resources Area (GEMA).

The purpose of the present study is to assess the potential for locatable, leasable and salable resources within the WSA, and specifically within each of the ASAs. This assessment has been carried out through literature study of the geology, structure and economic geology of the GEA, and a consideration of the regional paleogeographic, plate tectonic and metallogenic setting of the GEA within the southern Cordillera. Thus, the assessment is not only based on data from the GEA itself, but also on metallogenic concepts within the regional paleogeographic and plate tectonic framework.

Location and Access

The Sonora GEA is located within Maricopa, Pima and Gila Counties, southern Arizona. The WSA lies mostly within the Mineral Resource Area of the BLM-administered Phoenix District, and partially in the Gila Resource Area of the BLM-administered Safford District. The GEA is located in the south central part of the Ajo 1:250,000 quadrangle, approximately between latitudes 32° and 32°30' and longitudes 110°30' and 111°30'.

The White Canyon WSA (020-187) covers 6968 acres, and its location is shown in figure 1. Not shown on Fig 1.

Railroad access through the southern half of the GRA is provided by the Southern Pacific Railroad, and on the west side to the town of Superior in the northern half of the GRA by the Magma Arizona Railroad. Access is also provided by U.S. Highway 89 and 70-60 and Arizona State Highway 177. Numerous light duty roads and unimproved roads also exist in the lowlands; a lesser number of unimproved roads are present in the more mountainous areas of the GRA. The town of Superior and Kearny are located in the GRA, along with the western outskirts of Miami. The smaller towns of Sonora, Ray, Price, Cochran, Inspiration, Kelvin and Florence Junction are also present within the GRA boundary. Globe lies approximately 5 miles to the east of the GRA; Florence is a mile to the west of the GRA boundary. Phoenix lies approximately 30 miles to the west of the GRA. Tuscon lies some 55 miles to the south.

PHYSIOGRAPHY

The southwestern third of the Sonora GRA lies within the Sonora Desert section and the rest of the GRA lies within the Mexican Highland section of the Basin and Range province south of the Colorado Plateau (Fenneman, 1931; Heindl and Lance, 1960; Arizona Bureau of Mines, 1969). The area has a pronounced northwest trending topographic grain which reflects Miocene Basin and Range normal faulting. Subsequent erosion of the fault scarps has occurred forming pediments predominantly in the southwestern section of the GRA. the area has been free of tectonic activity for the past few million years; this is reflected in the formation of pediments in the southwest and the development of canyons and valleys and small pediments to the northeast.

The Sonora GRA can be divided into three different physiographic

The White Canyon WSA (020-167) covers 3968 acres, and its location is shown in Figure 1. (See Summary, p. 1).

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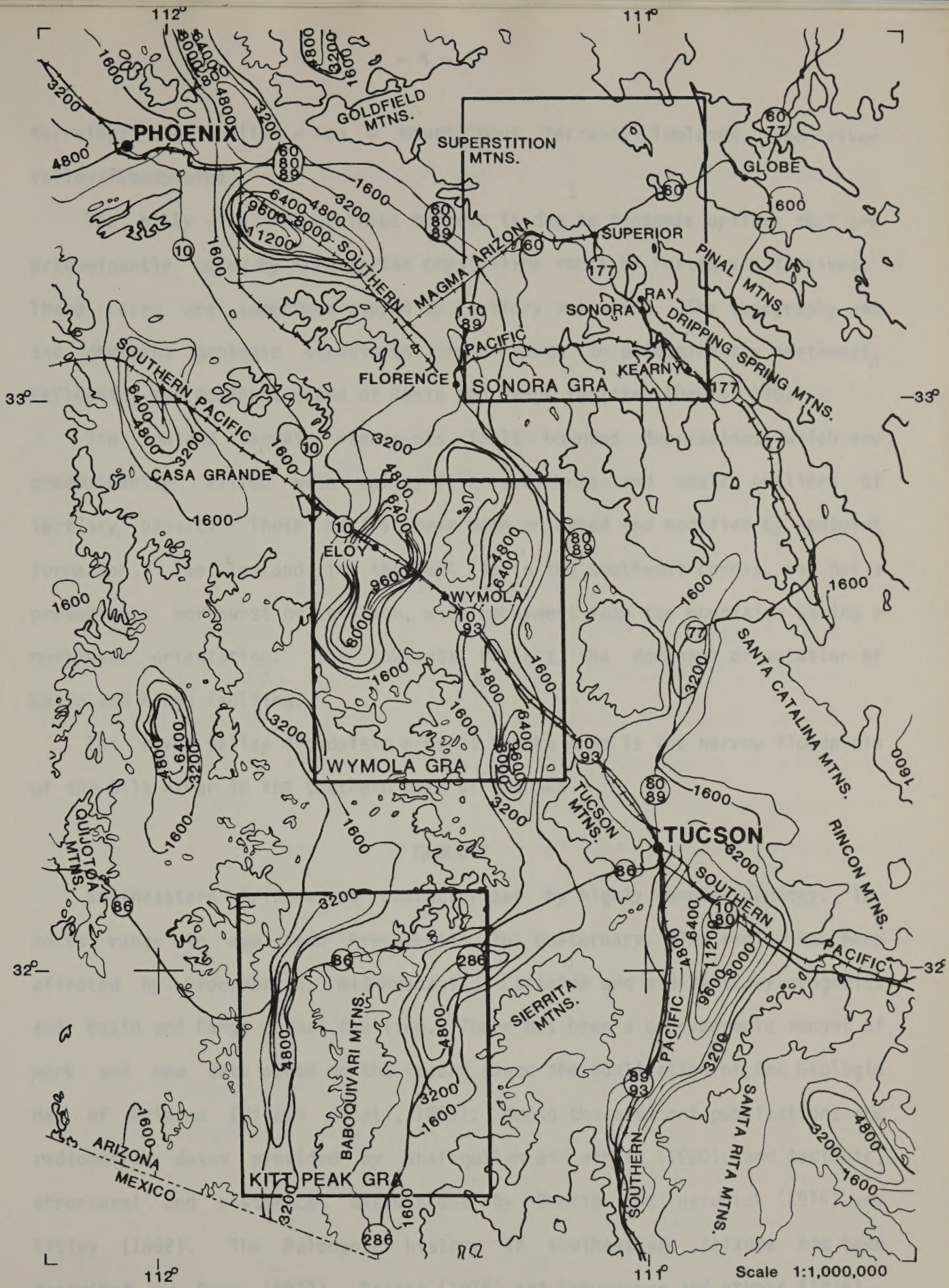

FIG. 1. PHYSIOGRAPHIC MAP OF SOUTH-CENTRAL ARIZONA SHOWING LOCATION OF SONORA, WYMOLA AND KITT PEAK AREAS. Depth to bedrock contours, interval =1600 ft., from Oppenheimer and Sumner (1980).

terrains: a hilly - to - mountainous terrain, lowlands, and river valley/floodplains.

The hilly - to - mountainous terrain is due to tectonic uplifts that are predominantly cored by Precambrian crystalline rocks or Tertiary intrusives. These cores are sometimes capped by Tertiary volcanics. The topography and the dominant geologic structures trend north to predominantly northwest, reflecting the dominant trend of Basin and Range faulting (Davis, 1981).

The lowland terrain represents fault bounded depressions which are predominantly filled with valley-fill sediments and small outliers of Tertiary basalt. These basins have been enlarged and modified by pediment formation. The lowland in the GRA is in the southwest corner, and has a predominant northwest orientation, with embayment into the mountains having a northeast orientation. The lowlands reflect the dominant orientation of Basin and Range faulting.

The river valley floodplain present in the area is the narrow floodplain of the Gila River in the southern part of the GRA.

GEOLOGY

Southeastern Arizona is characterized by highly complex geology. The rocks range in age from Precambrian to Quaternary. The region has been affected by Precambrian, mid-Mesozoic, Laramide and mid-Tertiary orogenies and Basin and Range normal faulting. There has been a considerable amount of work and new data added to the record since the publication of the Geologic Map of Arizona (Wilson et al., 1969). Among these recent publications are radiometric dates provided by Shafiqullah and others (1980), and tectonic, structural and historical discussions by Rehrig and Heidrick (1976) and Titley (1982). The Paleozoic history of southeastern Arizona has been described by Ross (1973), Peirce (1976) and Schumacher and others (1976).

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Recognition and discussion of the relationship between subduction magmatism and metallogenesis in the southern Cordillera is found in Coney and Reynolds (1977), Davis and others (1980) and Shafiqullah and others (1980). Cenozoic basins have been extensively mapped during the 1970's in the search for uranium (Eberly and Stanley, 1978; Scarborough and Wilt, 1979).

The lithology and stratigraphy, structural geology and tectonics, paleontology and geologic history of the Sonora GRA are discussed in this section to aid in the assessment of mineral potential within the GRA and, specifically, within the WSA. The regional geologic setting and detailed geology of the Sonora GRA are shown in figures 2 and 3.

Lithostratigraphy-Rock Units

The oldest rocks in southeastern Arizona are the older Precambrian Pinal Schists. These rocks are intruded by younger Precambrian intrusives and overlain by a succession of younger Precambrian continental and marine sediments, Paleozoic marine sediments, Mesozoic volcanics and sediments, Laramide intrusives and extrusives, mid-Tertiary volcanic and valley-fill sediments, and late Tertiary and Quaternary valley-fill sediments. The area was affected by intense orogenic activity and metamorphism in the Precambrian, mid-Mesozoic, Laramide and mid-Tertiary. Basin and Range normal faulting has modified the geology of the area (Shafiqullah et al., 1980; Titley, 1982; Banks et al., 1972).

Older Precambrian Rocks

Older Precambrian rocks crop out most extensively in the central Mountain region of Arizona, which crosses through the northeastern section of the Sonora GRA. Here they have been divided into three distinct northeast-trending belts (Titley, 1982; see fig. 2A) which, according to Anderson (1976), accreted onto the North American Craton from the southeast.

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Figure 2: Paleotectonic and paleogeographic maps of Arizona showing location of the Sonora GRA.

A. Location of Precambrian terrains and the Holbrook, Bright Angle-Mesa Butte and Colorado lineaments, after Warner (1978) and Titley (1982).

B. Location of mid-Mesozoic magmatic arc, the Mojave-Sonora megashear and mid- to late Mesozoic red beds, after Dickinson (1981). The red beds postdate the magmatic arc and probably extend farther to the southwest than shown.

C. Location and age trends of major porphyry copper deposits. Note that these are aligned parallel to northwest-trending Paleozoic-Mesozoic discontinuities (Lowell, 1974; numbers 1-6 correspond to discontinuities named in Heidrick and Titley, 1982), along northwest-trending Laramide magmatic arcs (v pattern), and along northeasterly Precambrian trends (Heidrick and Titley, 1982). Curved black lines show location of arc at different times, as given.

D. Location of Precambrian alkali and alkali-calcic intrusions and mid-Tertiary metamorphic core complexes, mid-Tertiary alkali-calcic volcanics and sedimentary domains (Scarborough and Wilt, 1979).

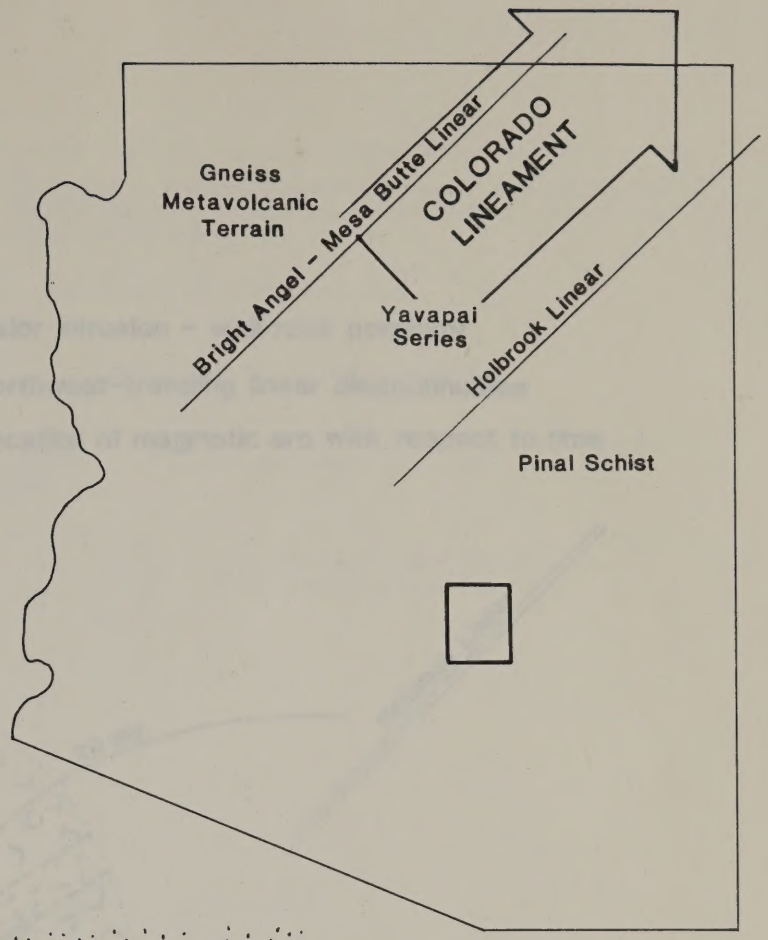
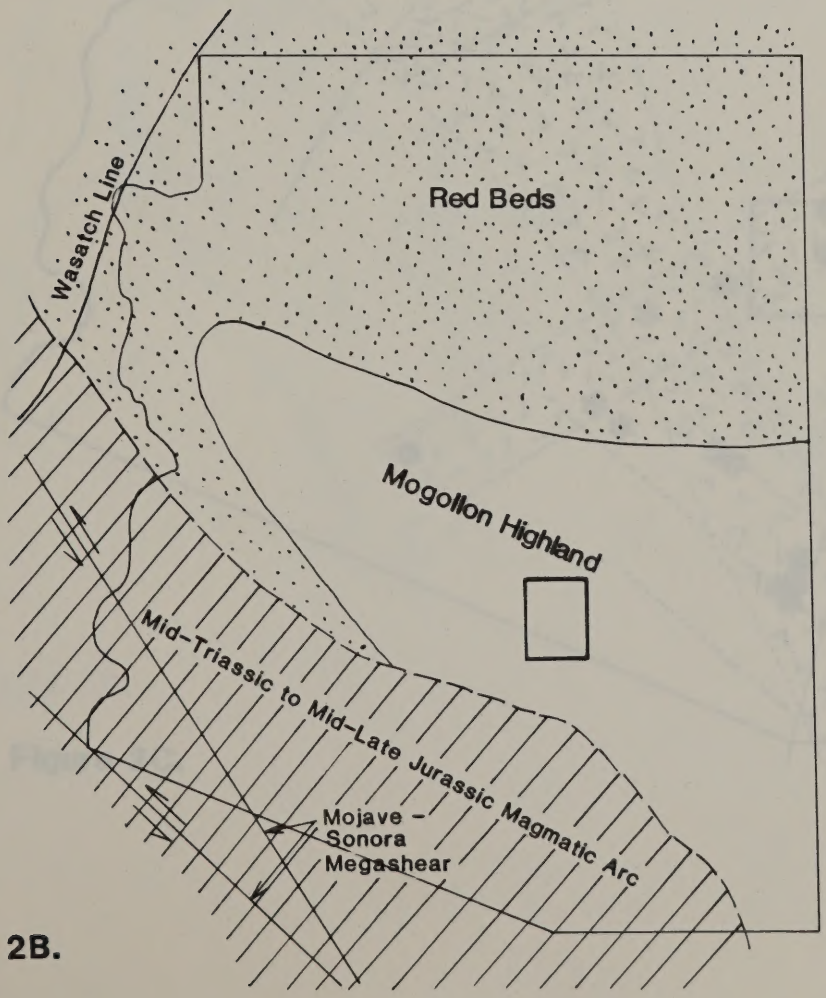


Figure 2A.



Scale
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Figure 2B.

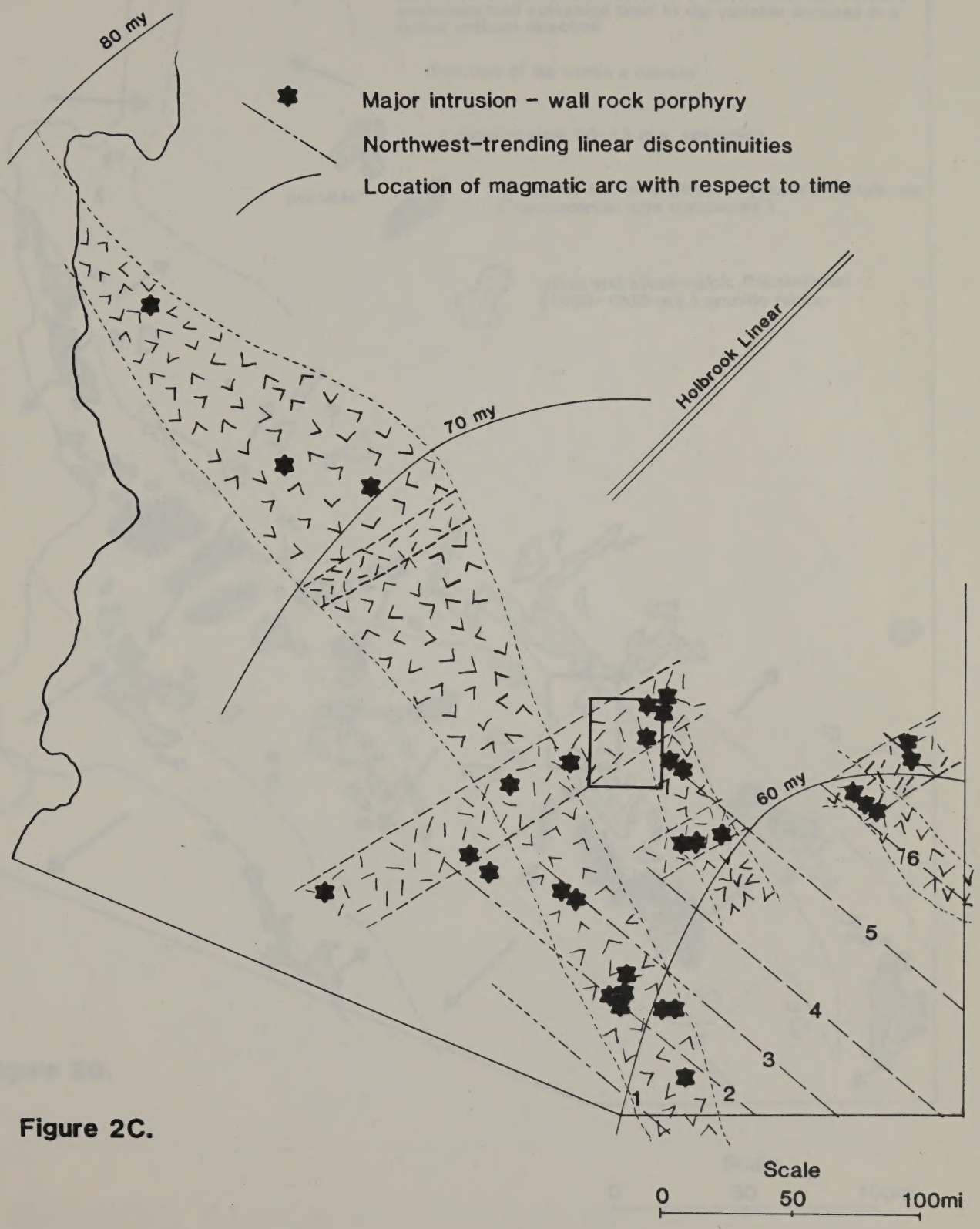
80 my
Major intrusion – wall rock porphyry
Northwest–trending linear discontinuities
Location of magmatic arc with respect to time
Holbrook Linear
70 my
60 my
1
2
3
4
5
6
Scale
0
50
100mi

Figure 2C.

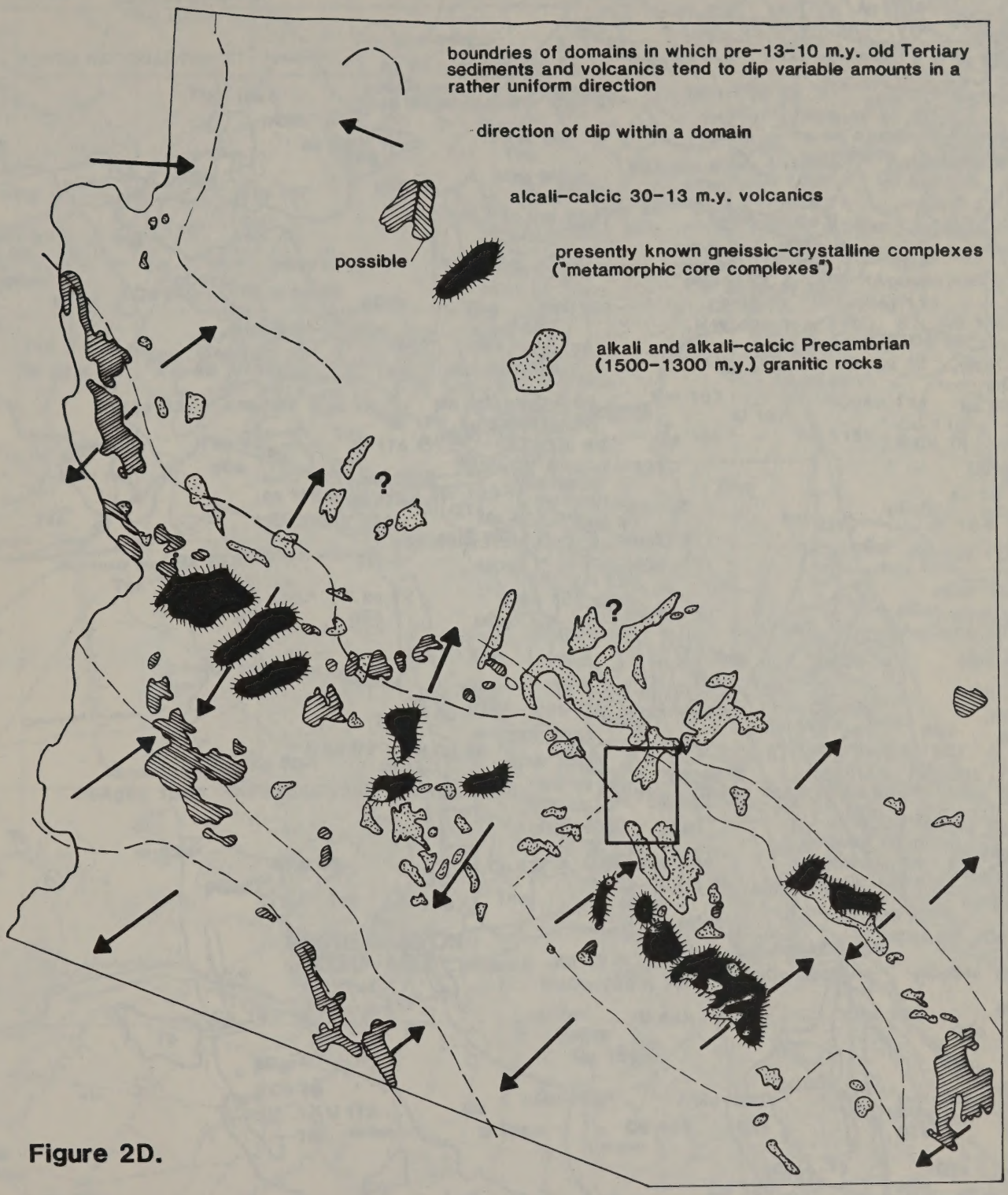

Figure 2D.

Scale

0 50 100mi

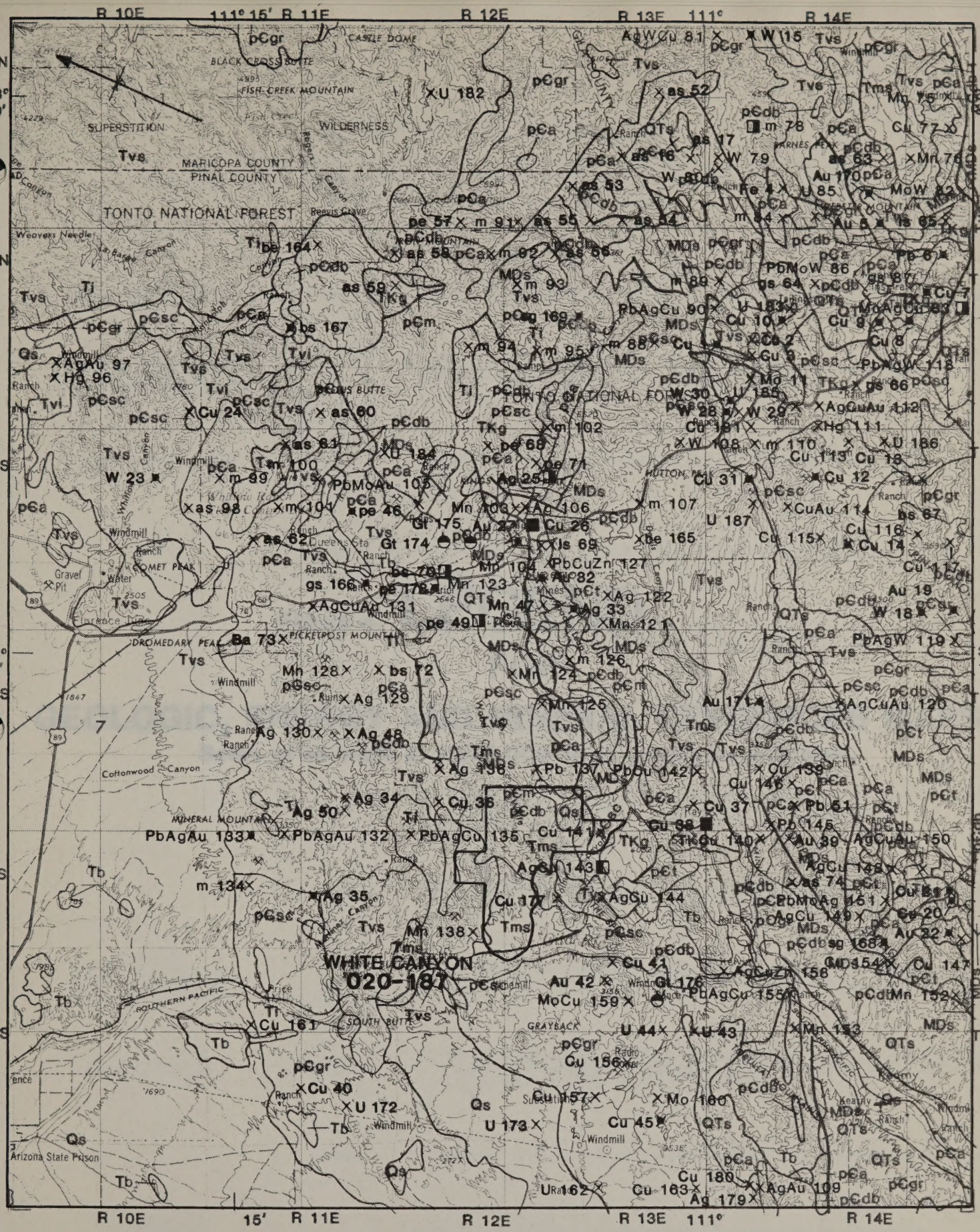

FIG. 3 GEOLOGIC, ENERGY AND MINERAL RESOURCES MAP OF THE SONORA AREA, ARIZONA

Scale
1 : 250,000
LEGEND: see enclosed

Figure 4. LEGEND
FOR
GEOLOGIC, ENERGY AND MINERAL RESOURCES MAPS

Scale of all maps is 1:250,000 or as otherwise indicated.

LITHOSTRATIGRAPHY

After Wilson et al. (1969) with modifications from Johnson (1981), Shafiqullah et al. (1980), Eberly and Stanley (1978), Shafiqullah et al. (1976), Yeend (1976), and Peterson (1969).

QUATERNARY	Qs	ALLUVIUM - Sand, gravel, silt, stream deposits, fans and pediment cappings.
LATE TERTIARY TO QUATERNARY	QTs	SEDIMENTS - Fanglomerate, sandstone and siltstone, may include minor basalt. Locally contains Gila Conglomerate.
LATE TERTIARY	Tb	BASALT - Flows and flow breccias of basalt and basaltic andesite composition.
MID TERTIARY	Ts	SEDIMENTS - Fluvial sandstones, fanglomerate, lacustrine sediments.
	Tvi	INTERMEDIATE VOLCANICS - Andesite, trachyandesite, trachyte, latites, quartz latites. Flows, ash flow tuffs, tuff breccia.
	Ti	DIKES, SILLS, PLUGS AND SMALL STOCKS - Locally includes Woodcamp Canyon Stock.
	Tvs	TERTIARY SILICIC VOLCANICS - Felsic volcanics, flows, ash flow tuffs, tuff breccias, interbeds of fluvial sediments, fanglomerates, lacustrine sediments. Locally contains Apache Leap Tuff.
	Tms	SEDIMENTS - Fluvial sandstones, fanglomerates, minor lacustrine sediments and volcanics. Locally includes Whitetail Conglomerate.
LATE CRETACEOUS TO TERTIARY	TKg	LARAMIDE INTRUSIVES AND RELATED VOLCANICS - Plutonic rocks, quartz diorite to granite. Locally includes Late Cretaceous volcanics.
PALEOZOIC	MDs	IN ASCENDING ORDER: MARTIN FORMATION (DEVONIAN), ESCABROSA LIMESTONE (MISSISSIPPIAN) AND NACO LIMESTONE (PENNSYLVANIAN) - Limestone, dolomite, shale and sandstone.
YOUNGER PRECAMBRIAN	p€db	DIABASE - Sills and dikes. Locally includes post Precambrian diabase.
	p€t	TROY QUARTZITE - Locally includes Cambrian Abrigo Formation and Bolsa Quartzite.
	p€a	APACHE GROUP - In ascending order: The Pioneer Formation, Dripping Spring Quartzite, and Mescal Limestone. Locally includes basalt flows.

LITHOSTRATIGRAPHY

After Wilson et al. (1969) with modifications from Johnson (1987), Shafiqullah et al. (1980), Eberly and Stanley (1978), Shafiqullah et al. (1976), Vennd (1975), and Peterson (1968).

OLDER PRECAMBRIAN	p€gr	GRANITIC ROCKS – Oracle granite in southern part of area, Madera diorite in eastern part of area; elsewhere quartz diorite to granite.
	p€m	MAZATZAL QUARTZITE.
	p€sc	PINAL SCHIST – Mostly metasedimentary schists; dominantly quartz-muscovite schist.

SPECIAL SYMBOLS

OF STRUCTURAL FEATURES

After U.S. Geological Survey

Contact – Dashed where approximately located; short dashed where inferred; dotted where concealed

45 Contact – Showing dip; well exposed at triangle

Fault – Dashed where approximately located; short dashed where inferred; dotted where concealed

20 Fault, showing dip – Ball and bar on downthrown side

Normal fault – Hachured on downthrown side

Fault – Showing relative horizontal movement

Thrust fault – Sawteeth on upper plate

Anticline – Showing direction of plunge; dashed where approximately located; dotted where concealed

Asymmetric anticline – Short arrow indicates steeper limb

Overturned anticline – Showing direction of dip of limbs

Syncline – Showing direction of plunge; dashed where approximately located; dotted where concealed

Asymmetric syncline – Short arrow indicates steeper limb

Overturned syncline – Showing direction of dip of limbs

Monocline – Showing direction of plunge of axis

20 Minor anticline – Showing plunge of axis

60 Minor syncline – Showing plunge of axis

Strike and dip of beds – Ball indicates top of beds known from sedimentary structures

70 Inclined ⊕ Horizontal

Vertical 40 Overturned

Strike and dip of foliation

20 Inclined Vertical Horizontal

Strike and dip of cleavage

15 Inclined Vertical Horizontal

Bearing and plunge of lineation

15 Inclined Vertical Horizontal

Strike and dip of joints

40 Inclined Vertical Horizontal

Note: planar symbols (strike and dip of beds, foliation or schistosity, and cleavage) may be combined with linear symbols to record data observed at same locality by superimposed symbols at point of observation. Coexisting planar symbols are shown intersecting at point of observation.

SPECIAL SYMBOLS

FOR ENERGY AND MINERAL RESOURCES

KNOWN DEPOSITS AND OCCURRENCES

- -O Oil field
- -G Gas field
- -Os Oil shale
- -C Coal deposit
- -C Coal occurrence
- -Mineral orebody - as specified with symbol
- -Mineral deposit - as specified with symbol
- -Mineral occurrence - as specified with symbol
- -Mineral district (Fig.= inserted map)

EXPLORATION AND/OR MINING ACTIVITY

MINERALS AND COAL

- Mineral deposit, mine or prospect with recorded prod.
- Prospect or mine with no recorded production
- Accessible adit, or tunnel
- Inaccessible adit, or tunnel
- Vertical shaft
- Inclined shaft
- Active open pit, or quarry
- Inactive open pit, or quarry
- Active gravel or clay (cl) pit
- Inactive gravel or clay (cl) pit
- Exploration hole with data available
- Exploration hole without data
- Mining district (Fig.= inserted map)

PETROLEUM

- Oil well
- Oil and gas well
- Gas well
- Show of gas
- Show of oil
- Show of oil and gas
- Shut-in well
- CO_2- or He-helium- rich well
- Dry well - abandoned

GROUND WATER

- Water well of special importance
- Water well of high yield
- Flowing water well
- Brine
- Mineral water
- Thermal water
- Radioactive water
- Thermal point

ENERGY RESOURCES

O Oil	C Coal	U Uranium
G Gas	Cb Lignite (brown coal)	Th Thorium
Os Oil shale	Cp Peat	Gt Geothermal
Ot Tar sands		

MINERAL RESOURCES

METALS

Al Aluminum
Sb Antimony
As Arsenic
Be Beryllium
Bi Bismuth
Cd Cadmium
Cr Chromium
Cs Cesium
Co Cobalt
Cu Copper
Ga Gallium
Ge Germanium
Au Gold
Fe Iron
Pb Lead
Li Lithium
Mn Manganese
Hg Mercury
Mo Molybdenum
Ni Nickel
Nb Niobium or Columbium
Pt Platinum group
RE Rare earth
Re Rhenium
Sc Scandium
Ag Silver
Te Tellurium
Tl Thallium
Sn Tin
Ti Titanium
W Tungsten
V Vanadium
Zn Zinc
Zr Zirconium and Hf Hafnium

NONMETALS - INDUSTRIAL MINERALS

ab Abrasives
al Alum
as Asbestos
Ba Barite
be Bentonite
ca Calcite
cl Clay
Construction materials:
cs Crushed stone
la Lightweight aggregates, includ.:
pm Pumice and volcanic cinders
pe Perlite
ec Expanded clay, shale, slate
vm Vermiculite
sg Sand and gravel
cr Cement raw materials
bs Building stones
li Lime
di Diatomite
Nonmarine and marine evaporites and brines
pt Potash
na Salt - mainly halite
gy Gypsum and anhydrite
nc Sodium carbonate or sulfate
bn Boron minerals
ni Nitrates
Sr Strontium
Br Bromine
cc Calcium chloride
mg Magnesium compounds
fs Feldspar
F Fluorite (fluorspar)
gs Gem stones
ge Graphite
He Helium
ki Kaolin
ky Kyanite and related minerals
ls Limestone
lm Lithium minerals
mg Magnesian refractories
mi Mica
ph Phosphate
pi Pigment and fillers
qz Quartz crystals
si Silica sand
S Sulfur
tc Talc
ze Zeolites
hm Humate

SPECIAL GEOLOGICAL FEATURES

POINT OF SPECIAL GEOLOGIC INTEREST

m	Mineral occurrence	s	Structural, bedding, foliation, etc.,	u	Radioactive spring
f	Fossil locality	b	Brecciation, shear zone, etc.,	g	Thermal spring
v	Volcanic phenomenon	y	High yield spring	a	Extensive rock alteration
t	Stratigraphic sequence	p	Spring with mineral water	r	Lithologic type locality

FAVORABILITY POTENTIAL AND LEVEL OF CONFIDENCE FOR MINERAL RESOURCES

FAVORABILITY:

1A - Undefined

1 - Not favorable - combine with either B, C, or D

2 - Low
3 - Moderate
4 - High
} combine with either A, B, C, or D

LEVEL OF CONFIDENCE:

A - Insufficient data

B - Indirect evidence

C - Direct evidence

D - Abundant direct and indirect evidence

The northwestern belt consists of gneisses which are in part metavolcanic (Stensrud and More, 1980) and were deposited about 1.8 b.y.B.P. (Titley, 1982). The central belt consists of the Yavapai Series which was deposited 1.82 - 1.775 b.y.B.P. (Anderson and Silver, 1976). It is a greenstone belt which is approximately 40,000 feet thick and is dominated by volcanic and volcaniclastic rocks of basaltic to rhyolitic composition (Anderson and Silver, 1976; Titley, 1982) and has been metamorphosed to the greenschist facies. Massive sulfide copper-zinc deposits are associated with submarine rhyolitic volcanism, especially in the Prescott-Jerome area (Donelly and Hahn, 1981). The southeastern belt consists of the Pinal Schists which were deposited 1.7 - 1.68 b.y.B.P. (Silver, 1978) and consist of quartz-muscovite schist, arkose and quartzite (Titley, 1982). Locally in the Sonora GRA andalusite and sillimanite are present (Peterson, 1969).

Older Precambrian rocks crop out throughout the Sonora GRA, with the exception of the extreme southwestern corner which consists predominantly of Quaternary sediments and late Tertiary basalts. These older Precambrian rocks consist of the Pinal Schist, Mazatzal Quartzite and granitic intrusives (Madera Diorite, Ruin or Oracle Granite). The Madera Diorite is dated at 1630 + 60 m.y.B.P. (Banks et al., 1972), and dates from Shafiqullah and others (1980) indicate that the Oracle or Ruin granitic intrusives occurred between 1400 and 1450 m.y.B.P.

Younger Precambrian

Younger Precambrian rocks crop out extensively in southeastern Arizona. They are described in Shride (1967), Banks and Krieger (1977), Peterson (1969), Cornwall and others (1971) and Cornwall and Krieger (1975). Within the GRA the Apache Group (Mescal Limestone, Dripping Spring Quartzite and Pioneer Formation), the Troy Quartzite and Diabase (which intrudes these

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Younger Precambrian

Younger Precambrian rocks crop out extensively in southeastern Arizona. They are described in Shride (1967), Banks and Krieger (1977), Peterson (1969), Cornwall and others (1971) and Cornwall and Krieger (1975). Within the GRA the Apache Group (Mescal Limestone, Dripping Spring Quartzite and Pioneer Formation), the Troy Quartzite and Diabase (which intrudes these

rocks) crop out.

The lowermost member of the Apache Group is the Pioneer Formation. It consists of a basal conglomerate (Scanlon Conglomerate member) up to twenty feet thick which is composed of clasts of the underlying Pinal Schist or Ruin (or Oracle) Granite. The main body of the Pioneer Formation is commonly about 250 feet thick, but in the Sonora quadrangle it varies from 230 to 250 feet (Cornwall et al., 1971). The formation consists of tuffaceous siltstone with subordinate interbedded arkosic sandstone. It is commonly orange-red to dark purple in color.

The Dripping Spring Quartzite includes the basal Barnes Conglomerate Member which ranges in thickness from 1 to 50 feet. The conglomerate is light gray to gray and consists of well rounded pebbles and cobbles of quartzite, schist and siltstone. The middle member averages about 200 feet of thickness in the GRA, and consists of arkose and feldspathic quartzite that is fine- to coarse-grained, white to brown in color and commonly exhibits cross bedding. The uppermost unit is commonly up to 500 feet thick, and consists predominantly of siltstone with interbeds of shale and fine-grained arkose. It contains cross bedding and is grayish to grayish red in color.

The Mescal Limestone varies up to 350 feet in thickness, and consists of a pinkish gray to brown dolomite that is locally calcareous. It is generally aphanitic or fine grained, but is locally medium- to coarse-grained. Black to light brown chert is present in some layers. It is generally thin-bedded with undulating to even bedding planes.

The Apache Group in most areas is capped by a porphyritic basalt, ranging up to 60 feet thick.

The Troy Quartzite is separated from the Apache Group by an angular unconformity. The Quartzite varies up to 800 feet in thickness within the

rocks) crop out.

The lowermost member of the Apache Group is the Pioneer Formation. It consists of a basal conglomerate (Scanlon Conglomerate member) up to twenty feet thick which is composed of clasts of the underlying final Schist or Ruin (or Oracle) Granite. The main body of the Pioneer Formation is commonly about 250 feet thick, but in the Sonora quadrangle it varies from 230 to 250 feet (Cornwall et al., 1971). The formation consists of tuffaceous siltstone with subordinate interbedded arkosic sandstone. It is commonly orange-red to dark purple in color.

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The Troy Quartzite is separated from the Apache Group by an angular unconformity. The Quartzite varies up to 800 feet in thickness within the

GRA. The main body of the Troy Quartzite is made up of quartzite and sandstone that varies from grayish white or white to light brown or grayish orange (Cornwall et al., 1971). Present to a much lesser extent are conglomerates, particularly in the lower part of the section, where they are commonly composed of pebbles and cobbles of sandstone, quartzite, chert, basalt, limestone and Pinal Schist.

The youngest Precambrian rock present in the Sonora GRA is diabase, dated at 1040 m.y. by Banks and others (1972). The diabase intrudes all other Precambrian rocks, and forms both sills and dikes. It is dark gray to olive gray and is varies from being fine- to coarse-grained with a diabasic or ophitic texture. Contact metamorphic effects are especially evident in the Mescal Limestone which contains the assemblage tremolite, forsterite, talc and diopside (Banks and Krieger, 1977).

Paleozoic

The geologic record for the Paleozoic in southeastern Arizona indicates a shallow epicontinental sea environment. The record is preserved in rocks of upper Cambrian and Devonian through Permian age. There is no evidence of magmatic activity during the Paleozoic in southeast Arizona. The Paleozoic rocks present in the Sonora GRA consist of the upper Cambrian Bolsa Quartzite and Abrigo Formation, the upper Devonian Martin Formation, the Mississippian Escabrosa Group, and the lower- to mid-Pennsylvanian Naco Limestone. In figure 3, the Cambrian rocks are included within the Troy Quartzite, and younger Paleozoic rocks are represented by the Mississippian-Devonian sedimentary rock unit (MDs).

The Bolsa Quartzite varies in thickness up to 700 feet (Titley, 1982). In the Sonora GRA it is rarely over 400 feet thick and is commonly much less (Cornwall et al., 1971; Cornwall and Krieger, 1975). It is comprised

SRA. The main body of the Troy Quartzite is made up of quartzite and sandstone that varies from greyish white or white to light brown or greyish orange (Cornwall et al., 1971). Present to a much lesser extent are conglomerates, particularly in the lower part of the section, where they are commonly composed of pebbles and cobbles of sandstone, quartzite, chert, basalt, limestone and final schist.

The youngest Precambrian rock present in the Sonora SRA is diabase, dated at 1000 m.y. by Banks and others (1972). The diabase intrudes all other Precambrian rocks, and forms both sills and dikes. It is dark gray to olive gray and its varies from being fine- to coarse-grained with a diabasic or ophitic texture. Contact metamorphic effects are especially evident in the Mescal Limestone which contains the assemblage tremolite, forsterite, talc and diopside (Banks and Krieger, 1977).

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The Troy Quartzite varies in thickness up to 700 feet (Titley, 1982). In the Sonora SRA it is rarely over 400 feet thick and is commonly much less (Cornwall et al., 1971; Cornwall and Krieger, 1975). It is comprised

primarily of a quartizitic sandstone with sub-rounded or well-rounded quartz grains in a well cemented siliceous matrix, in part ferruginous or kaolinitic. Bedding is commonly thin or laminated; rarely the unit is thick bedded. Cross bedding is prominant in some beds. The Bolsa Quartzite is commonly white to pinkish gray or light brown. The basal section contains arkosic sandstone, mudstone and conglomerate of a moderate brown color (Cornwall et al., 1971; Peterson, 1969). The basal section is largely derived from nearby older rocks and fills irregularities on an eroded surface of moderate relief (Peterson, 1969).

The Abrigo Formation varies considerably in thickness and lithology in southeastern Arizona due to pre-Paleozoic relief (Peterson, 1969), and at its thickest approaches 800 feet (Titley, 1982; Banks and Krieger, 1977). In the Sonora GRA, it varies from zero to 220 feet in thickness. It consists of varying proportions of thinly bedded and interbedded mudstone, siltstone, sandstone, quartzite and dolomite. Locally thick beds of quartzite are found. The dolomite unit commonly contains phosphatic brachiopod fragments (Banks and Krieger, 1977). The color of the rocks of the Abrigo Formation vary from reddish brown and grayish orange to yellowish and light gray (Peterson, 1969; Cornwall et al., 1971; Cornwall and Krieger, 1975).

The upper Devonian Martin Limestone varies in thickness in the Sonora GRA but is commonly between 300 and 400 feet thick. The thickness is thought to vary due to relief on the erosional surface it is deposited on (Banks and Krieger, 1977). The formation is composed primarily of dark gray to olive gray thin-bedded or laminated very fine- or fine-grained dolomite. The base commonly consists of sandy dolomite or dolomitic quartzite. Thinly bedded sandstone and shaly limestone beds are scattered throughout the formation. The upper part of the formation commonly consists of thinly bedded orange-yellow to grayish yellow calcareous shale (Peterson, 1969; Banks and

primarily of a quartzitic sandstone with sub-rounded or well-rounded quartz grains in a well cemented siliceous matrix, in part fortuitous or sericitic. Bedding is commonly thin or laminated; rarely the unit is thick-bedded. Cross bedding is prominent in some beds. The Dolsa Quartzite is commonly white to pinkish gray or light brown. The basal section contains arkosic sandstone, mudstone and conglomerate of a moderate brown color (Cornwall et al., 1971; Peterson, 1969). The basal section is largely derived from nearby older rocks and fills irregularities on an eroded surface of moderate relief (Peterson, 1969).

The Abrigo Formation varies considerably in thickness and lithology in southeastern Arizona due to pre-Paleozoic relief (Peterson, 1969), and at its thickest approaches 600 feet (Titley, 1982; Banks and Krieger, 1977). In the Sonora USGS, it varies from zero to 250 feet in thickness. It consists of varying proportions of thinly bedded and intraformational mudstone, siltstone, sandstone, quartzite and dolomite. Locally thick beds of quartzite are found. The dolomite unit commonly contains pseudomatic brachiopod fragments (Banks and Krieger, 1977). The color of the rocks of the Abrigo Formation vary from reddish brown and greyish orange to yellowish and light gray (Peterson, 1969; Cornwall et al., 1971; Cornwall and Krieger, 1978).

The upper Devonian Martin Limestone varies in thickness in the Sonora USGS but is commonly between 300 and 400 feet thick. The thickness is thought to vary due to relief on the erosional surface it is deposited on (Banks and Krieger, 1977). The formation is composed primarily of dark gray to olive gray thin-bedded or laminated, very fine- or fine-grained dolomite. The base commonly consists of sandy dolomite or dolomitic quartzite. Thinly bedded sandstone and shaly limestone beds are scattered throughout the formation. The upper part of the formation commonly consists of thinly bedded orange-yellow to greyish yellow calcareous shale (Peterson, 1969; Banks and

Krieger, 1977).

The lower Mississippian Escabrosa Limestone reaches a maximum of about 750 feet in thickness in southeastern Arizona. In the Sonora GRA it reaches approximately 550 feet thick. In places it lies disconformably on the Martin Limestone, and contains reworked silt and clay from the uppermost part of the Martin section (Banks and Krieger, 1977). The basal section of the Escabrosa commonly consists of limestone or dolomite with a thin layer of sandstone at the base. The overlying rock is medium to dark gray fossiliferous-micritic limestone which is locally altered to granular dolomite. In the upper part of the Formation a white or light gray limestone occurs, which is overlain by gray and brown fossiliferous limestone which is locally dolomitized. Chert nodules occur throughout the section.

The Naco Limestone is lower to middle Pennsylvanian in age (Banks and Krieger, 1977), and varies greatly in thickness (0-500+ feet) within the Sonora GRA. The formation is characterized by evenly spaced units of resistant limestone and less resistant shaly or silty limestone. Thin beds of shale and siltstone and chert nodules and lenses occur throughout the section. The Limestone is aphanitic or fine grained, and commonly light yellowish gray to very light gray. The base of the formation is commonly marked by about fifteen feet of reddish to purple fissile shale, similar to the shale interbeds dispersed throughout the section.

Mesozoic

Pre-Laramide Mesozoic rocks are poorly documented within the Sonora GRA. Sedimentary rocks of the Mesozoic have not been reported within the Sonora GRA, but do crop out to the east in the Christmas area (upper Cretaceous sediments underlying the Williamson Canyon Volcanics). The Mesozoic rocks present in the GRA are predominantly igneous in origin. Radiometric dates

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The lower Mississippian Escabrosa Limestone reaches a maximum of about 750 feet in thickness in southeastern Arizona. In the Sonora GRA it reaches approximately 550 feet thick. In places it lies disconformably on the Martin Limestone, and contains reworked silt and clay from the uppermost part of the Martin section (Banks and Kriegger, 1977). The basal section of the Escabrosa commonly consists of limestone or dolomite with a thin layer of sandstone at the base. The overlying rock is medium to dark gray fossiliferous-micritic limestone which is locally altered to granular dolomite. In the upper part of the formation a white or light gray limestone occurs, which is overlain by gray and brown fossiliferous limestone which is locally dolomitized. Chert nodules occur throughout the section.

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are not available for many rocks due to hydrothermal alteration, so structural, intrusive and stratigraphic controls are the only available means of dating these rocks. Mesozoic basaltic sills and rare dikes are reported to crop out within the GRA (Cornwall et al., 1971; Cornwall and Krieger, 1975; Banks and Krieger, 1977). These basaltic sills are commonly porphyritic, and are rarely over five feet thick. They are commonly dark gray to olive-gray, and appear hydrothermally altered. The sills and dikes are found intruding the Abrigo, Martin, Escabrosa and Naco formations. Due to alteration of the primary minerals, radiometric dating is not possible (Banks et al., 1972). These basaltic sills and dikes are too small to be represented on the geologic map of figure 3.

Cretaceous rocks are only dated relatively in this area, as mentioned above for all Mesozoic rocks. Basaltic and andesitic rocks crop out in the Sonora GRA that are mapped as Cretaceous in age. Among these are the Williamson Canyon Volcanics. These volcanics are present in small outcrops in the eastern part of the GRA, and increases in thickness eastward out of the GRA up to a thickness of over 950 feet (Banks and Krieger, 1977; Cornwall and Krieger, 1975). The volcanics are medium to dark gray or greenish gray flows, flow breccias, volcaniclastics and minor tuffs. Xenoliths of Troy Quartzite and unidentified rock fragments are present. These rocks are commonly moderately altered, with plagioclase moderately to heavily altered to sericite, kaolinite, calcite and epidote; hornblende is commonly epidotized and pyroxene is chloritized (Banks and Krieger, 1977; Cornwall and Krieger, 1975). The Williamson Canyon Volcanics have been dated at about 80 m.y. (Koski and Cook, 1982, from Titley, 1982), and are considered to be part of the Laramide period.

Other rocks that are mapped as upper Cretaceous consist of basaltic and andesitic sills and dikes. These all consist of small outcroppings, and crop

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Other rocks that are mapped as upper Cretaceous consist of basaltic and andesitic sills and dikes. These all consist of small outcroppings, and crop

out in the Dripping Spring Mountains. In the central Dripping Spring Mountains a basaltic breccia pipe crops out with clasts ranging in size from crystal fragments to 90 feet or more in diameter. In all of these rocks, the phenocrysts are partially to completely altered, similar to the Williamson Canyon volcanics. It is possible that these rocks represent the earliest stages of Laramide activity, but radiometric dates are unavailable due to alteration.

Laramide Orogeny Period

The Laramide was a period of volcanism, intrusion and intense tectonic activity in southern Arizona. It is of particular importance because a large number of porphyry copper deposits were formed at this time, especially in southeastern Arizona (Damon and Mauger, 1966; Shafiqullah et al., 1980; Titley, 1981; Heidrick and Titley, 1982; see fig. 2). The magmatic and tectonic activity was related to a southeastward sweep of the magmatic arc as the dip of the Benioff zone decreased (Coney and Reynolds, 1977; Clark et al., 1982).

Laramide rocks crop out in the northeast, north, and southeast (bordering the White Canyon WSA) areas of the GRA. The Laramide intrusive rocks vary from the early phase of the orogenic event being predominantly quartz diorite through granodiorite and quartz monzonite compositions for the younger stages of the orogenic period. These granitic Laramide rocks intrude Pinal Schist, Precambrian granitics, younger Precambrian sediments and Paleozoic sediments. They are associated with porphyry copper deposits at Castle Dome, Ray, Inspiration and Globe-Miami (Inspiration and Globe-Miami deposits lie just to the east of the GRA) where they intrude Pinal Schist. The Laramide volcanic rocks range in composition from early basaltic and andesitic rocks to later rhyodacitic rocks. The Laramide igneous rocks are

out in the Dripping Spring Mountains. In the central Dripping Spring Mountains a basaltic breccia pipe crops out with clasts ranging in size from crystal fragments to 30 feet or more in diameter. In all of these rocks, the phenocrysts are partially to completely altered, similar to the Williamson Canyon volcanics. It is possible that these rocks represent the earliest stages of Laramide activity, but radiometric dates are unavailable due to alteration.

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characterized by having a calc-alkaline differentiation trend.

Mid-Tertiary

Mid-Tertiary rocks are here defined to include all sedimentary and igneous rocks deposited after the Laramide orogeny and the post-Laramide period of peneplanation, and before Basin and Range type faulting became prominant. These pre-Basin and Range rocks have been divided into three units by Eberly and Stanley (1978) and Scarborough and Wilt (1979).

The lowest unit consists of indurated, red to brown arkosic fluvial sandstone, fanglomerates of gneissic and granitic provenance up to 600 feet or more thick, and minor lacustrine sediments with some algal limestone. Andesitic to rhyolitic volcanics increase in abundance towards the upper part of this unit.

The middle unit is characterized by voluminous intermediate to felsic volcanism that is associated with the mid-Tertiary orogeny. The volcanics consist of flows, ash flow tuffs, tuff breccias and ash of latitic, quartz latitic, rhyolitic and trachytic composition and flows and flow breccias of basaltic, basaltic andesite, and andesitic composition (Reynolds, 1980). Small intrusions of the above compositions are also present. The volcanic rocks are interbedded with red sand and gravel fluvial deposits, massive fanglomerates, and lacustrine deposits with local organic-rich facies, algal limestones, and water-laid tuffs.

The upper unit consists of grayish brown, poorly consolidated sandstones, fanglomerates, mudstones, and water-laid tuffs. The rocks contain abundant volcanic debris. They are overlain and intercalated with basaltic volcanic mudstones in lacustrine deposits and contain fresh water ostracods.

The mid-Tertiary rocks rest unconformably on Precambrian, Paleozoic,

characterized by having a calc-alkaline differentiation trend.

Mid-Tertiary

Mid-Tertiary rocks are here defined to include all sedimentary and igneous rocks deposited after the Laramide orogeny and the post-Laramide period of peneplanation, and before Basin and Range type faulting became prominant. These pre-Basin and Range rocks have been divided into three units by Eberly and Stanley (1978) and Scarborough and Wilt (1979).

The lowest unit consists of indurated, red to brown arkosic fluvial sandstone, fanglomerates of granitic and granitic provenance up to 600 feet or more thick, and minor lacustrine sediments with some algal limestone. Andesitic to rhyolitic volcanics increase in abundance towards the upper part of this unit.

The middle unit is characterized by voluminous intermediate to felsic volcanism that is associated with the mid-Tertiary orogeny. The volcanics consist of flows, ash flow tuffs, tuff breccias and ash of latitic, quartz latitic, rhyolitic and trachytic composition and flows and flow breccias of basaltic, basaltic andesite, and andesitic composition (Reynolds, 1980). Small intrusions of the above compositions are also present. The volcanic rocks are interbedded with red sand and gravel fluvial deposits, massive fanglomerates, and lacustrine deposits with local organic-rich facies, algal limestones, and water-laid tuffs.

The upper unit consists of grayish brown, poorly consolidated sandstones, fanglomerates, mudstones, and water-laid tuffs. The rocks contain abundant volcanic debris. They are overlain and interrelated with basaltic volcanic mudstones in lacustrine deposits and contain fresh water ostracods.

The mid-Tertiary rocks rest unconformably on Precambrian, Paleozoic,

Mesozoic and Laramide rocks. They were deposited in northwest-striking basins which were tilted northeastward and southwestward as shown in figure 2D (Scarborough and Wilt, 1979).

The mid-Tertiary volcanic rocks lie mainly in the middle unit, but they do extend into the lower and upper units. The volcanism was extremely voluminous, and in southwestern Arizona about a million cubic kilometers were emptied (Shafiqullah et al., 1980). These may have been largely emptied from cauldrons such as have been identified in the Datil volcanics in southwestern New Mexico by Elston (1978) and Elston and Bornhorst (1979), and in the Superstition Superior volcanic field (Shafiqullah et al., 1980) northwest of the White Canyon WSA. Sub-volcanic aplitic granite cropping out in Reevis Canyon (Woodcamp Canyon stock, SE 1/4 of SE 1/4, sec. 4, T1S, R12E) north of the White Canyon WSA has been dated at 18.35 m.y.B.P. (Shafiqullah et al., 1980; Peterson, 1969). This plutonic body may be a plug related to caldera activity (Shafiqullah et al., 1980). The volcanism lasted from 35 m.y.B.P. to about 12 m.y.B.P., with the interval between 24 and 12 m.y.B.P. being the transition from the mid-Tertiary orogeny to Basin and Range faulting, which did not take place simultaneously throughout southern Arizona (Shafiqullah et al., 1980). In eastern Arizona the intensity of volcanism peaked about 26 m.y.B.P. and in western Arizona volcanism peaked about 21 m.y.B.P. as the volcanic arc swept westward during the steepening of the Benioff zone in the late Oligocene and early Miocene (Coney and Reynolds, 1977; Shafiqullah et al., 1980). Initially the volcanism was calc-alkaline, but as the main magmatic arc passed westward the volcanism became highly potassic with eruption of potassic trachyandestes and ultra-potassic trachytes (Shafiqullah et al., 1980). Towards the close of the mid-Tertiary orogeny, volcanism became almost entirely basaltic.

Within the Sonora GRA the mid-Tertiary rocks crop out with a large areal

Mesozoic and Laramide rocks. They were dissected in northwest-striking belts which were tilted northeastward and southwestward as shown in Figure 20 (Scarborough and Wilt, 1979).

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Within the Sonora GRA the mid-Tertiary rocks crop out with a large areal

extent in the White Canyon area, Walnut Canyon area, east of Superior and in the northwest quarter of the GRA. Smaller outcrops are found in the northeast corner of the GRA.

Included within the mid-Tertiary rocks is the Whitetail Conglomerate of Oligocene age. The Whitetail Conglomerate is of variable thickness due to the high relief of the lower erosional contact (Scarborough and Wilt, 1979). The thickness varies from 0 to 2000 feet thick or more (Peterson, 1969; Cornwall et al., 1971). In the Ray area it buried an irregular surface with up to 500 feet of relief (Kennecott, written communication). The lower section of the Whitetail is composed of monolithic rock fragments, therefore it is derived from a nearby source. The lower section of Whitetail Conglomerate is commonly composed of one or more of the following: Pinal schist, Ruin (Oracle) Granite, Precambrian or Paleozoic sedimentary rocks or various Laramide intrusives. Near the White Canyon WSA the Whitetail Conglomerate is composed of 99% fragments from an oxidized, mineralized and partly leached capping of Pinal Schist. These fragments are red, hematitic and cuprous altered schist clasts (Kennecott, written communication). Fluviatile siltstones are sporadically interbedded with the Early Whitetail Conglomerate (Kennecott, written communication; Scarborough and Wilt, 1979). The later Whitetail Conglomerate is formed from a mixed source area. There are commonly interstratified water-laid tuffs in this upper portion (Kennecott, written communication; Peterson, 1969). Near the top of the section an air fall tuff has been dated (Silberman, 1971, personal communication reported in Cornwall et al., 1971) by K-Ar at 32 m.y.B.P.

The Miocene Apache Leap Tuff is rhyodacitic in composition and varies in thickness from very thin remnants to 2000 feet thick at the type section (Peterson, 1969; Cornwall et al., 1971) and is commonly about 500 feet thick. The unit consists of multiple flows that acted as a single cooling unit. It

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The Miocene Aquarius Lake Tuff is rhyodacitic in composition and varies in thickness from very thin remnants to 2000 feet thick at the type section (Peterson, 1969; Cornwall et al., 1971) and is commonly about 500 feet thick. The unit consists of multiple flows that acted as a single cooling unit. It

consists of a basal tuff, vitrophyre and an overlying welded crystal tuff. The welded tuff makes up the great majority of the unit (Kennecott, written communication). Creasey and Kistler (1962, reported in Cornwall et al., 1971) obtained a K-Ar date of 20 m.y.B.P. on biotite of the Apache Leap Tuff.

Various isolated conglomerate bodies are also present in the area, and commonly contain interbedded ash flow tuffs.

Late Tertiary

Late Tertiary deposits are found in all the tectonic basins formed during the Basin and Range disturbance. The depth of these basins have been estimated by Oppenheimer and Sumner (1980) through gravity modeling and drill hole data and is summarized in figure 1. The depths of these basins are highly variable, but the basin present in the southwest corner of the Sonora GRA reaches a depth of greater than 3200 feet.

The deposits consist mainly of poorly consolidated, tan colored fanglomerate, sandstone, and siltstone of fluvial and lacustrine origin, minor basalt and felsic tuffs (Scarborough and Wilt, 1979; Reynolds, 1980). These deposits rest unconformably on mid-Tertiary or older rocks.

The initiation of Basin and Range faulting and deposition of basin-fill sediments took place 13-12 m.y.B.P. according to Eberly and Stanley (1978). Shafiqullah and others (1980), however, present evidence to show that the transition from the mid-Tertiary orogeny to the Basin and Range disturbance took place over the time interval between 19 and 12 m.y.B.P., and that the basaltic volcanism decreased in intensity from 9 to 4 m.y.B.P. The interval during which Basin and Range tectonism, volcanic activity and sedimentation was dominant in southern Arizona was probably 14-4 m.y.B.P. (Shafiqullah et al., 1980), though some basaltic volcanism is as young as 1 m.y.B.P. Within the Sonora GRA, basaltic volcanism has been dated at 8.8 m.y.B.P.

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The initiation of Basin and Range faulting and deposition of basin-fill sediments took place 13-12 m.y.B.P. according to Eberly and Stanley (1978) Shafiqullah and others (1980). However, present evidence to show that the transition from the mid-Tertiary orogeny to the Basin and Range disturbance took place over the time interval between 10 and 12 m.y.B.P., and that the basaltic volcanism decreased in intensity from 8 to 6 m.y.B.P. The interval during which Basin and Range tectonism, volcanic activity and sedimentation was dominant in southern Arizona was probably 14-4 m.y.B.P. (Shafiqullah et al., 1980), though some basaltic volcanism is as young as 1 m.y.B.P. Within the Sonora GRA, basaltic volcanism has been dated at 8.8 m.y.B.P.

Latest Tertiary to Quaternary

During the last four million years volcanic and tectonic activity has slowed down in southern Arizona. The dominant geological processes have been erosion of ranges and formation of extensive pediments, deposition of fanglomerates and deposition of alluvium, mainly near the Gila River.

Structural Geology

The GRA lies within the North American craton and east of the Wasatch Line and has been affected by tectonism during Proterozoic, mid-Mesozoic, Laramide and mid-Tertiary orogenies and most recently by the Basin and Range disturbance. The area is, therefore, structurally very complex. It is only recently, and largely as a result of detailed structural studies and extensive radiometric dating, that the structure and tectonics of the area have begun to be understood. Particularly important recent studies include strain analysis of various deformations by Davis (1981) and a summary of recent radiometric dates by Shafiqullah and others (1980).

During the Arizonan revolution, 1.76 to 1.63 b.y.B.P. (Damon, 1968), the Precambrian rocks were folded about ENE-striking axes and underwent N-S to NNW faulting (Davis, 1981). The Colorado lineament (see fig. 2A), a major strike-slip system according to Warner, was initiated about this time and its southwestern extension passes to the northwest of the GRA.

No pronounced tectonic or igneous activity took place during the Paleozoic, but southern Arizona was strongly affected by a mid-Mesozoic magmatic arc and a later period of metamorphism and folding. The magmatic arc extended across southern and southwestern Arizona (south of the Sonora GRA) during the mid-Jurassic and produced voluminous volcanism and granitic plutonism. Northwest trending strike slip faulting was initiated (Davis, 1981) and movement along the Mojave-Sonora left-lateral megashear (see fig.

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2B) probably took place at this time (Silver and Anderson, 1974). Northwest-trending linear discontinuities in depositional patterns (see fig. 2C) were produced in southeastern Arizona (Titley, 1976).

The Laramide was a period of intense tectonism and localized magmatic activity which was associated with the southeastward migration of the magmatic arc (Coney and Reynolds, 1977; Lowell, 1974). The Laramide basement-cored uplifts and thrust faults which strike NNW to NW (Nielsen, 1979; Davis, 1981); the WNW left-lateral strike slip faulting of the Texas zone of Schmitt (1966); and the ENE-striking tensional features (Rehrig and Heidrick, 1976) are all probably related to ENE plate motion and compression. Laramide plutons associated with porphyry copper mineralization have a pronounced NNW to NW trend and a secondary ENE trend (Heidrick and Titley, 1982; see fig. 2). the former is parallel to the Laramide magmatic arc and basement-cored uplifts, and the latter is parallel to Precambrian fold axes and Laramide tensional features. One of these ENE trends passes through the Sonora GRA (see fig. 2C).

The mid-Tertiary orogeny lasted from approximately 34 to 14 m.y.B.P. (Shafiqullah et al., 1980) and involved eruption of large volumes of volcanic rocks, emplacement of metamorphic core complexes and listric normal faulting. These geologic events accompanied the steepening of the Benioff zone and the resultant westward migration of magmatic arc at this time (Coney and Reynolds, 1977).

The volcanism produced enormous volumes of ignimbrite eruptions and was dominantly calc-alkaline but became potassic in the later stages. In southwestern New Mexico similar volcanics originated from numerous cauldrons (Elston and Bornhorst, 1979). Cauldrons are present in the Superior-Superstition volcanic field northwest of the White Canyon WSA, which cuts across the northwestern corner of the Sonora GRA. A small granitic

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The mid-Tertiary orogeny lasted from approximately 36 to 24 m.y.B.P. (Shafiqullah et al., 1980) and involved eruption of large volumes of volcanic rocks, emplacement of metamorphic core complexes and listric normal faulting. These geologic events accompanied the steepening of the Benioff zone and the resultant westward migration of magmatic arc at this time (Coney and Reynolds, 1977).

The volcanism produced enormous volumes of ignimbrite eruptions and was dominantly calc-alkaline but became potassic in the later stages. In southwestern New Mexico similar volcanics originated from numerous caldrons (Elston and Bornhorst, 1979). Caldrons are present in the Superior-Silverstrike volcanic field northwest of the White Canyon NGA, which cuts across the northwestern corner of the Sonora GRA. A small granitic

stock north of the WSA may be related to caldera activity (Shafiqullah et al., 1980). Metamorphic core complexes and listric normal faulting are not known to be present in the GRA.

Between 19 and 12 m.y.B.P. a transition occurred between the mid-Tertiary orogeny and Basin and Range faulting. The Basin and Range faults strike NW to N-S and are high angle faults (Davis, 1981). The present day ranges and basins result from this tectonic episode. Within the GRA the structural depression in the southwest corner filled with Late Tertiary sediments formed at this time. The Basin and Range tectonic episode was terminated about 4 m.y.B.P. (Shafiqullah et al., 1980).

Geologic History

The geologic history of central Arizona is long and complex and only a brief synopsis is presented here. Excellent summaries of the main geological events that affected the southern part of the North American Cordillera are given by Burchfiel (1979) and Dickinson (1981). More detailed accounts pertaining particularly to southwestern and southern Arizona are given by Shafiqullah and others (1980) and Reynolds (1980). The geologic history can be summarized as follows:

1. Volcanic and clastic rocks were accreted onto the North American continent from the southeast 1.8-1.7 b.y.B.P. (Anderson, 1976; Anderson and Silver, 1976; Silver, 1978; Titley, 1982). The boundary between the dominantly volcanic and volcaniclastic Yavapai Series and the clastic non-volcanic Pinal Schists coincides with the Holbrook Linear which passes to the northwest of the GRA (see fig. 2). The rocks were folded about northeasterly axes, metamorphosed to the greenschist and amphibolite facies and intruded by granitic batholiths during the Arizonan Revolution about 1.7-1.6

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Between 15 and 12 m.y.B.P. a transition occurred between the mid-Tertiary orogeny and Basin and Range faulting. The Basin and Range faults strike NW to N-S and are high angle faults (Davis, 1981). The present day ranges and basins result from this tectonic episode. Within the GRA the structural depression in the southwest corner filled with late Tertiary sediments formed at this time. The Basin and Range tectonic episode was terminated about 4 m.y.B.P. (Shafiqullah et al., 1980).

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b.y.B.P.(Damon, 1968), and then intruded by anorogenic granites 1.5 to 1.4 b.y.B.P. Silver et al., 1977).

2. Sometime after this, but before 1.2-1.1 b.y.B.P., the area was uplifted and eroded. The area contained in the GRA was submerged beneath epicontinental seas and shallow marine clastic sediments and carbonates of the Late Proterozoic Apache Group were deposited (Heindl and McClymonds, 1964) This group was then capped by basaltic flows. Uplift and erosion occurred, followed by the shallow marine deposition of the Troy Quartzite. These rocks were intruded by diabase sills 1.1 to 1.2 b.y.B.P. The area covered by the GRA remained above sea level at this time.
3. The area was uplifted and bevelled, and during the Cambrian age the GRA was again submerged beneath epicontinental seas. At this time, shallow marine clastic sandstone, mudstone and minor limestone were deposited (Heindl and McClymonds, 1964).
4. No deposition took place during the Ordovician and Silurian, and the Cambrian is disconformably overlain by a thick Devonian to Early Mississippian and minor Pennsylvanian transgressive sequence of fluvial sandstone, shallow marine clastic rocks and dolomitic carbonate rock (Teichert, 1965; Bryant, 1968).
5. No record of Late Paleozoic sediments is found, and possibly they were removed by erosion during the mid-Mesozoic orogeny. Molasse-like sediments were deposited in local basins to the east of the GRA (Heindl, 1965; Banks and Krieger, 1977), but are not found within the GRA.
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characterized by NNW to NW striking basement-cored uplifts and thrust faults (Nielsen, 1979; Davis, 1981); WNW-striking, left-lateral faults of the Texas zone (Schmitt, 1966); ENE-striking tensional features (Rehrig and Heidrick, 1976); and intrusion of small epizonal plutons along NW and ENE trends (Heidrick and Titley, 1982). The magmatic activity proceeded from northwest to southeast as the dip of the Benioff zone flattened in the time interval from 70 to 50 m.y.B.P. (Coney and Reynolds, 1977).

7. The Laramide was followed by a period of tectonic quiet and erosion.

8. The mid-Tertiary orogeny lasted from about 35 to 14 m.y.B.P. During this time, a great thickness of fluvial and lacustrine sediments interbedded with voluminous felsic to intermediate volcanics were deposited in northwest-striking basins (Eberly and Stanley, 1978; Scarborough and Wilt, 1979). The volcanism was mainly calc-alkaline (Shafiqullah et al., 1980) and was dominated by ignimbrite eruptions from cauldrons. Coeval with the volcanism was the emplacement of metamorphic core complexes which occur along a northwest-trending zone (Coney, 1980) to the south of the GRA. Volcanism and tectonism migrated westward during the mid-Tertiary as the dip of the Benioff zone steepened (Coney and Reynolds, 1977).

9. After the westward passage of the magmatic arc, steep, normal Basin and Range faulting became dominant after about 14 m.y.B.P. (Shafiqullah et al., 1980). At this time basalt became the predominant volcanic rock, the present ranges were uplifted, and the basins were filled with fluvial and

characterized by NNW to NW striking basement-cored uplifts and thrust faults (Hinds, 1979; Davis, 1981); WNW-striking, left-lateral faults of the Texas zone (Smith, 1969); ENE-striking tensional features (Ewing and Meldrick, 1974); and intrusion of small epicontinental plutons along NW and ENE trends (Meldrick and Titley, 1982). The magmatic activity proceeded from northwest to southeast as the dip of the Benioff zone flattened in the time interval from 70 to 30 m.y.B.P. (Coney and Reynolds, 1977).

7. The Laramide was followed by a period of tectonic quiet and erosion.

8. The mid-Tertiary orogeny lasted from about 35 to 14 m.y.B.P. During this time, a great thickness of fluvial and lacustrine sediments interbedded with voluminous felsic to intermediate volcanics were deposited in northwest-striking basins (Ewing and Gonzalez, 1976; Scarborough and Wilt, 1979). The volcanism was mainly calc-alkaline (Shafiqullah et al., 1980) and was dominated by ignimbrite eruptions from caldrons. Coeval with the volcanism was the emplacement of metamorphic core complexes which occur along a northwest-trending zone (Coney, 1980) to the south of the SRA. Volcanism and tectonism migrated westward during the mid-Tertiary as the dip of the Benioff zone steepened (Coney and Reynolds, 1977).

9. After the westward passage of the magmatic arc, extension, normal faults and Range faulting became dominant after about 14 m.y.B.P. (Shafiqullah et al., 1980). At this time basalts preceded the predominant volcanic rock, the present ranges were uplifted, and the basins were filled with fluvial and

lacustrine sediments.

10. Since 4 m.y.B.P. volcanism and tectonism have been minor (Shafiqullah et al., 1980), and the dominant geologic processes have been erosion of ranges resulting in the formation of extensive pediments and deposition of fans in the basins and alluvium along major rivers.

Paleontology

Paleontological documentation is important for three major reasons, as follows:

a) guide fossils which in the sedimentary sequence are most useful for stratigraphic correlation,

b) outstanding fossil specimens or fossils which are extraordinarily well preserved can be beneficial to science and/or tourism, and

c) fossils can be excellent indicators of the paleogeographic and paleoecological environments; as a result, even moderately to poorly preserved "uninteresting" fossils can be geologically important.

Plant fossils must also be considered important as organic material can trigger the precipitation of uranium and/or other metals.

The following is a brief summary of the sedimentary formations of the Sonora GRA and White Canyon WSA listing types of fossils present. To the authors' knowledge, there are no fossil localities of outstanding importance, either scientifically or as curiosities.

Older metamorphic rocks of the Sonora GRA include the metasedimentary Pinal Schist which was deposited 1.7-1.68 b.y.B.P. The Apache group, of late Precambrian age, includes siltstone and quartzite of the Pioneer Formation;

lacustrine sediments.

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Older metamorphic rocks of the Sonora GRA include the metasedimentary Pinal Schist which was deposited 1.7-1.68 b.y.B.P. The Apache group, of late Precambrian age, includes siltstone and quartzite of the Pioneer Formation

the Dripping Spring Quartzite, which contains siltstone and mudstone beds as well as quartzite; and the Mescal Limestone, a dolomite with siltstone and mudstone beds. Also present in the GRA is the Troy Quartzite, which consists of quartzite and sandstone. To the knowledge of the authors, none of these Precambrian rocks of the Sonora GRA contain fossils.

Paleozoic fossil bearing formations crop out in the GRA, including in the far northeastern corner of the WSA. Trilobites are prevalent in the upper section of the Cambrian Bolsa quartzite, and trilobites and fucoids are common in the upper Cambrian Abrigo Formation (Heindl and McClymonds, 1964; Banks and Krieger, 1977). The Devonian Martin Limestone commonly contains brachiopods, crinoids, spiriferoids and bryozoa (Banks and Krieger, 1977; Cornwall and Krieger, 1975). Other fossils, not specifically reported to occur within the GRA but contained within the Martin Limestone are coalified plant remains, gastropods, fish and ostracods (Teichert, 1965). The Mississippian Escabrosa Limestone contains brachiopods, corals, ostracods and crinoids (Cornwall and Krieger, 1975; Banks and Krieger, 1977; Cornwall et al., 1971). Bryozoans have been reported elsewhere in the Escabrosa, and they may or may not be found within the GRA (Bryant, 1968). Fusilinids, brachiopods, corals, crinoids, bryozoa and ostracods have been reported in the Pennsylvanian Naco Limestone.

Mesozoic sedimentary rocks are not reported within the Sonora GRA.

The lowest mid-Tertiary unit of Scarborough and Wilt (1979) and Eberly and Stanley (1978) contains algal limestone in other areas. The Middle mid-Tertiary units of these authors consists of volcanic rocks interbedded with fluvial deposits, fanglomerates and possibly algal fluvial sands and gravels. No reports of plant or animal fossil occurrences in the late Tertiary and Quaternary basin fill sediments are known to the authors.

As mentioned previously, fossiliferous Paleozoic rocks crop out in the

the Driftwood Spring Quartzite, which contains siltstone and mudstone beds as well as quartzite; and the Moscal Limestone, a dolomite with siltstone and mudstone beds. Also present in the GRA is the Troy Quartzite, which consists of quartzite and sandstone. To the knowledge of the authors, none of these Precambrian rocks of the Sonora GRA contain fossils.

Paleozoic fossil bearing formations crop out in the GRA, including in the far northeastern corner of the USA. Trilobites are prevalent in the upper section of the Cambrian Bolsa quartzite, and trilobites and fucoids are common in the upper Cambrian Abrigo Formation (Heinod and McClymonds, 1961; Banks and Krieger, 1977). The Devonian Martin Limestone commonly contains brachiopods, crinoids, spiriferoids and bryozoa (Banks and Krieger, 1977; Cornwall and Krieger, 1975). Other fossils, not specifically reported to occur within the GRA but contained within the Martin Limestone are coalified plant remains, gastropods, fish and ostracods (Tetchert, 1965). The Mississippian Escabrosa Limestone contains brachiopods, corals, ostracods and crinoids (Cornwall and Krieger, 1975; Banks and Krieger, 1977; Cornwall et al., 1971). Bryozoans have been reported elsewhere in the Escabrosa, and they may or may not be found within the GRA (Bryant, 1968). Brachiopods, brachiopods, corals, crinoids, bryozoa and ostracods have been reported in the Pennsylvanian Naco Limestone.

Mesozoic sedimentary rocks are not reported within the Sonora GRA.

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As mentioned previously, fossiliferous Paleozoic rocks crop out in the

northeastern corner of the White Canyon WSA. The rest of the WSA is composed of Precambrian and Tertiary rocks. As stated above, fossils have not been reported in these rocks.

ENERGY AND MINERAL RESOURCES

The following are descriptions of known mineral deposits, prospects, occurrences, mineralized areas and thermal wells and other energy resources (fig. 3) in the Sonora GRA. Information was derived from the following sources: U.S. Geological Survey (1972, updated in 1977, 1978, 1979, 1981), U.S. Bureau of Mines (1982), Arizona Bureau of Mines (1969), Stipp and others (1967), McCrory and O'Haire (1965), Arizona Department of Natural Resources (1981), Witcher and others (1982), Cornwall and Krieger (1975), Johnson (1972), Peirce and others (1970), Luning and others (1982) and Kennecott (written communication). Scarborough and Wilt (1979) was also consulted for deposits and deposit descriptions. Figure 3 shows locations of the listed mines, mineral occurrences, and thermal wells.

Known Mineral Deposits, Mines or Prospects with Recorded Production

1. **Carlota Mine**
   Location: 33°23'6"N, 110°59'20"W
   Sec. 35, T1N, R13E.
   Commodity: Cu.
   Ore Materials: Malachite, Azurite, hydrated Cu silicates and chrysocolla.
   Deposit Description:
   Medium sized, irregular in veinlets, underground workings.
   Geology: Mineralization in Precambrian Pinal Schist associated with Early Tertiary diabase; deposit occurs in shattered rock along the Kelly fault zone. The copper minerals have clearly formed by direct deposition either from true or colloidal solutions that contained copper not derived from minerals originally present in the immediate host rock.
   Production: Yes, medium amount.
   References: U.S.G.S., 1979, CRIB Mineral Resources file 12, Record 397, p. 1072-1074; Stipp et al., 1967.

5. **Money Metals Mine**
   Synonym Name: Slumbering Beauty Group.

northeastern corner of the White Canyon WSA. The rest of the WSA is composed of Precambrian and Tertiary rocks. As stated above, fossils have not been reported in these rocks.

ENERGY AND MINERAL RESOURCES

The following are descriptions of known mineral deposits, prospects, occurrences, mineralized areas and thermal wells and other energy resources (Fig. 3) in the Sonora CRA. Information was derived from the following sources: U.S. Geological Survey (1972, updated in 1977, 1978, 1979, 1981), U.S. Bureau of Mines (1982), Arizona Bureau of Mines (1959), Stipp and others (1967), McCemry and O'Haire (1965), Arizona Department of Natural Resources (1981), Mitcher and others (1982), Cornwall and Krieger (1975), Johnson (1972), Pierce and others (1970), Lunting and others (1982) and Kanneccti (written communication). Scarborough and Wilt (1979) was also consulted for deposits and deposit descriptions. Figure 3 shows locations of the listed mines, mineral occurrences, and thermal wells.

Known Mineral Deposits, Mines or Prospects with Recorded Production

1. **Barbara Mine**

Location: 32°23'8"N, 110°59'20"W
Sec. 33, T1N, R13E.

Commodity: Cu.

Ore Materials: Malachite, Azurite, hydrated Cu silicates and chrysocolla.

Deposit Description: Medium sized, irregular in veinlets, underground workings.

Geology: Mineralization in Precambrian Pinal Schist associated with Early Tertiary diabase; deposit occurs in shattered rock along the Kelly fault zone. The copper minerals have clearly formed by direct deposition either from true or colloidal solutions that contained copper not derived from minerals originally present in the immediate host rock.

Production: Yes, medium amount.

References: U.S.G.S., 1979, CRIB Mineral Resources file 12, Record 397, p. 1072-1074; Stipp et al., 1967.

2. **Money Metals Mine**

Synonym Name: Slumbering Beauty Group.

Location: 33°26'27"N, 110°54'53"W
Sec. 10, T1N, R14E.
Commodities: Au, Ag, Pb (major); Zn (minor); Cu (occurrence).
Ore Materials: Galena, sphalerite, chalcopyrite and pyrite.
Deposit Description:
Small, striking N30°E, dipping 75°NW, lense shaped in vein, underground workings.
Geology: Mineralization in Precambrian Pioneer Formation associated with early Tertiary diabase dike; the diabase granite contact probably represents an old fault along which the Apache Group had been down dropped into contact with the granite before intrusion of the diabase; gouge and breccia are largely replaced by quartz, pyrite and chalcopyrite.
Production: Yes, small amount.
Reference: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 400, p. 1079-1081.

6. **Cedar Tree Mine**
Location: 33°26'15"N, 110°53'06"W
Sec. 13, T1N, R14E.
Commodities: Pb, Zn (major); Cu (occurrence).
Ore Materials: Galena, sphalerite, chalcopyrite and pyrite.
Deposit Description:
Small, striking N70°E, dipping 30°S, irregularly shaped in a replacement.
Geology: Mineralization in Precambrian Pinal Schist associated with early Tertiary diabase dike.
Production: Yes, small amount, less than 2500 tons.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 401, p. 1082-1083; Stipp et al., 1967.

7. **Warrior Group**
Location: 33°24'49"N, 111°53'46"W
Sec. 23, 24, T1N, R14E.
Commodities: Cu (major); Mn (occurrence).
Ore Materials: Chrysocolla and Mn oxides.
Deposit Description:
Small, linear shape in a replacement, underground workings.
Geology: Mineralization in Precambrian Pinal Schist associated with early Tertiary dacite; the main structure, which trends about due east, is made by two roughly parallel faults bounding a narrow depressed block.
Production: Yes, small amount.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 402, p. 1084-1086.

8. **Live Oak and Keystone**
Location: 33°24'14"N, 110°54'24"W
Sec. 26, T1N, R14E.
Commodity: Cu.
Ore Materials: Chrysocolla.
Deposit Description:

Location: 33°26'27"N, 110°54'53"W
Sec. 10, T1N, R14E.
Commodities: Au, Ag, Pb (major); Zn (minor); Cu (occurrence).
Ore Materials: Galena, sphalerite, chalcopyrite and pyrite.
Deposit Description:
Small, striking N30°E, dipping 75°NW, lense shaped in vein, underground workings.
Geology: Mineralization in Precambrian Pioneer Formation associated with early Tertiary diabase dike; the diabase granite contact probably represents an old fault along which the Apache Group had been down dropped into contact with the granite before intrusion of the diabase; gouge and breccia are largely replaced by quartz, pyrite and chalcopyrite.
Production: Yes, small amount.
Reference: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 600, p. 1079-1081.

6. Cedar Tree Mine
Location: 33°26'15"N, 110°53'06"W
Sec. 13, T1N, R14E.
Commodities: Pb, Zn (major); Cu (occurrence).
Ore Materials: Galena, sphalerite, chalcopyrite and pyrite.
Deposit Description:
Small, striking N70°E, dipping 30°S, irregularly shaped in a replacement.
Geology: Mineralization in Precambrian Pinal Schist associated with early Tertiary diabase dike.
Production: Yes, small amount, less than 2500 tons.
Reference: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 601, p. 1082-1083; Stoop et al., 1977.

7. Warrior Group
Location: 33°24'45"N, 111°53'45"W
Sec. 23, 24, T1N, R14E.
Commodities: Cu (major); Mn (occurrence).
Ore Materials: Chrysocolla and Mn oxides.
Deposit Description:
Small, lenser shape in a replacement, underground workings.
Geology: Mineralization in Precambrian Pinal Schist associated with early Tertiary dacite; the main structure, which trends about due east, is made by two roughly parallel faults bounding a narrow depressed block.
Production: Yes, small amount.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 602, p. 1084-1086.

8. Lone Oak and Keystone
Location: 33°24'14"N, 110°54'24"W
Sec. 26, T1N, R14E.
Commodity: Cu.
Ore Materials: Chrysocolla.
Deposit Description:

Small, linear shaped in veins, underground workings.

Geology: Mineralization in early Tertiary Schultze Granite; the chrysocolla undoubtedly was deposited by supergene solutions that collected in the fissures and contained copper leached from the surrounding rock.

Production: Yes, small amount.

References: U.S.G.S., 1978, CRIB Mineral Resources File 12, Record 403, p. 1087-1089.

9. **Castle Dome**

Location: 33°24'43"N, 110°57'18"W
Sec. 27, T1N, R14E.

Commodities: Cu, Ag, Au; turquoise (minor).

Ore Materials: Chalcopyrite, molybdenite, sphalerite, galena, pyrite, wavellite, metatorbernite, wulfenite, barite, fluorite and libethenite.

Deposit Description:
Medium, striking N75°E, dipping 85°S, linear shapes in veins, surface workings.

Geology: Alteration and mineralization are almost entirely confined to the quartz monzonite and the granite porphyry intruded into it. To the east, west and south the alteration either ends at the margins of the quartz monzonite or is very weak beyond them, whereas to the north, in the quartz monzonite, the alteration decreases gradually until it becomes unrecognizable in the field. The principal locus of deposition in this area is a set of closely spaced, nearly parallel fractures.

Production: Yes, medium amount.

References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 404, p. 1090-1092; Arizona Bureau of Mines, 1969.

10. **Sixty-four Group**

Location: 33°22'52"N, 110°58'45"W
Sec. 30, T1N, R14E.

Commodity: Cu.

Ore Materials: Chalcopyrite.

Deposit Description:
Small, linear shaped deposit in veinlets.

Geology: Mineralization in Precambrian schist associated with Tertiary dacite; the copper carbonates and silicate undoubtedly were deposited by ground water; and, since no evidence has been found of any concentration of copper minerals in the tuff that underlies the dacite and which is normally a good precipitant of copper, it is probable that the deposition occurred before the eruption of the tuff and dacite.

Production: Yes, small amount.

References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 405, p. 1093-1095; Stipp et al., 1967.

Geology: Small, linear shaped in veins, underground workings. Mineralization in early Tertiary Schultze Granite. the chrysocolla undoubtedly was deposited by supergene solutions that collected in the fissures and contained copper leached from the surrounding rock.

Production: Yes, small amount.

References: U.S.G.S., 1978, CRIB Mineral Resources File 12, Record 403, p. 1087-1089.

9. Tassie Down

Location: 33°24'43"N, 110°57'18"W
Sec. 27, T1N, R14E.

Commodities: Cu, Ag, Au; turquoise (minor).

Ore Materials: Chalcopyrite, molybdenite, sphalerite, galena, pyrite, wavellite, metatorbernite, autunite, barite, fluorite and litherite.

Deposit Description:
Medium, striking N75°E, dipping 85°S, linear shapes in veins, surface workings.

Geology: Alteration and mineralization are almost entirely confined to the quartz monzonite and the granite porphyry intruded into it. To the east, west and south the alteration, either ends at the margins of the quartz monzonite or is very weak beyond them, whereas to the north, in the quartz monzonite, the alteration decreases gradually until it becomes unrecognizable in the field. The principal locus of deposition in this area is a set of closely spaced, nearly parallel fractures.

Production: Yes, medium amount.

References: U.S.G.S., 1978, CRIB Mineral Resources File 12, Record 404, p. 1090-1092; Arizona Bureau of Mines, 1959.

10. Sixty-four Group

Location: 33°22'52"N, 110°54'45"W
Sec. 30, T1N, R14E.

Commodity: Cu.

Ore Materials: Chalcopyrite.

Deposit Description:
Small, linear shaped deposits in veinlets.

Geology: Mineralization in Precambrian schist associated with Tertiary dacite; the copper carbonates and silicate undoubtedly were deposited by ground water; and, since no evidence has been found of any concentration of copper minerals in the tuff that underlies the dacite and which is normally a good precipitant of copper, it is probable that the deposition occurred before the eruption of the tuff and dacite.

Production: Yes, small amount.

References: U.S.G.S., 1978, CRIB Mineral Resources File 12, Record 405, p. 1093-1095; Stipp et al., 1957.

12. **Gibson Cons. Copper Co.**
Location: 33°20'3"N, 110°56'30"W
Sec. 21, T1S, R14E.
Commodities: Cu, Ag (major); Be (occurrence).
Ore Materials: Copper sulfide.
Deposit Description:
Small, striking N25°E, dipping 55°NW, linear shaped in a vein, underground workings.
Geology: Mineralization in Precambrian Pinal Schist associated with early Tertiary Schultze Granite; the ore occurred in three lenticular shoots separated by intervals in which the vein fracture is obscure and practically barren of vein minerals; the Pasquale vein, though roughly parallel in strike, differs from the summit in that it dips about 35°NW and occupies a more clearly defined fracture zone that is not conformable with the bedding of the schist.
Production: Yes, small amount.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 458, p. 1245-1247; Stipp et al., 1967; Arizona Bureau of Mines, 1969.

14. **Cole and Goodwin**
Location: 33°17'56"N, 110°55'39"W
Sec. 34, T1S, R14E.
Commodities: Cu (major); Ag (minor).
Ore Materials: Chalcopyrite, Cu carbonates, pyrite and chalcocite.
Deposit Description:
Small, irregularly shaped in a replacement, underground workings.
Geology: Mineralization in Precambrian Pinal Schist, associated with early Tertiary Schultze Granite.
Production: Yes, small amount.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 460, p. 1250-1252; Stipp et al., 1967.

15. **Pinto Tungsten**
Synonym Name: Wagner
Location: 33°31'45"N, 110°59'21"W
Sec. 12, T2N, R13E.
Commodity: W.
Ore Materials: Wolframite, scheelite and pyrite.
Deposit Description:
Small, striking N35°W, dipping 88°NE, linear shaped in a vein, surface and underground workings.
Geology: Mineralization in early Tertiary granite associated with Tertiary pegmatite and aplite dikes, also quartz veins; sparse, very sporadic wolframite with small amounts of scheelite occurs in quartz veins.
Production: Yes, small amount.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 466, p. 1266-1268; Stipp et al., 1967.

18. **Samsel Mine**
Location: 33°16'43"N, 110°53'25"W

12. Gibson Cons. Copper Co.
Location: 33°20'3"N, 110°36'30"W
Sec. 21, T15, R14E.
Commodities: Cu, Ag (major); Be (occurrence).
Ore Materials: Copper sulfide.
Deposit Description:
Small, striking N25°E, dipping 55°NW, linear shaped in a vein, underground workings.
Geology: Mineralization in Precambrian Pinal Schist associated with early Tertiary Schultze Granite; the ore occurred in three lenticular shoots separated by intervals in which the vein fracture is obscure and practically barren of vein minerals; the Pasquale vein, though roughly parallel in strike, differs from the summit in that it dips about 35°NW and occupies a more clearly defined fracture zone that is not conformable with the bedding of the schist.
Production: Yes, small amount.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 458, p. 1245-1247; Stipp et al., 1967; Arizona Bureau of Mines, 1969.

14. Cole and Goodwin
Location: 33°17'56"N, 110°35'30"W
Sec. 34, T15, R14E.
Commodities: Cu (major); Ag (minor).
Ore Materials: Chalcopyrite, Cu carbonate, pyrite and chalcocite.
Deposit Description:
Small, irregularly shaped in a replacement, underground workings.
Geology: Mineralization in Precambrian Pinal Schist, associated with early Tertiary Schultze Granite.
Production: Yes, small amount.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 460, p. 1250-1252; Stipp et al., 1967.

15. Plate Tungsten
Synonym Name: Wagner
Location: 33°31'45"N, 110°39'21"W
Sec. 12, T2N, R13E.
Commodity: W.
Ore Materials: Wolframite, scheelite and pyrite.
Deposit Description:
Small, striking N35°W, dipping 85°NE, linear shaped in a vein, surface and underground workings.
Geology: Mineralization in early Tertiary granite associated with Tertiary pegmatite and aplite dikes, also quartz veins; sparse, very sporadic wolframite with small amounts of scheelite occurs in quartz veins.
Production: Yes, small amount.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 465, p. 1266-1268; Stipp et al., 1967.

16. Samuel Mine
Location: 33°16'43"N, 110°33'25"W

Sec. 11, T2S, R14E.
Commodities: W (major); Mo (potential); Au, Ag, Pb (occurrence).
Ore Materials: Wolframite, gold, galena, silver, pyritic molybdenite.
Deposit Description:
Small, striking N30°E, dipping 80°NW, linear shaped in a vein type deposit, underground workings.
Geology: Mineralization in Precambrian Pinal Schist associated with early Tertiary granodiorite; the vein matter is chiefly quartz and coarsely granular pyrite.
Production: Yes, small amount.
Reference: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 480, p. 1303-1305.

19. **Bobtail Mine**
Synonym Name: Mariana
Location: 33°16'22"N, 110°51'48"W
Sec. 12, T2S, R14E.
Commodities: Au, Ag, Cu (major); W (minor); Pb, Zn (occurrence).
Ore Materials: Hubnerite, scheelite, gold, silver, chalcopyrite, pyrite, galena and sphalerite.
Deposit Description:
Small, N55°E striking, dipping 62°NW, the form pinches and swells in a lense type deposit, underground workings.
Geology: Mineralization in Precambrian Pinal Schist associated with early Tertiary granite, diorite and diabase.
Production: Yes, small amount.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 481, p. 1306-1308; Stipp et al., 1967.

20. **Columbia Mine**
Location: 33°8'36"N, 110°51'46"W
Sec. 25, T3S, R14E.
Commodities: Cu (major); Ag, Au (minor).
Ore Materials: Cu carbonates, cuprite, pyrite and chalcopyrite.
Deposit Description:
Small, striking N89°E, dipping 75°S, linear shaped in a vein, underground workings.
Geology: Mineralization in Precambrian limestone associated with early Tertiary quartz diorite porphyry; heavy complex faulting is present.
Production: Yes, small amount.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 490, p. 1330-1332; Stipp et al., 1967.

21. **Dripping Springs Mine**
Synonym Name: Columbia.
Location: 33°8'36"N, 110°51'46"W
Sec. 25, T3S, R14E.
Commodities: Cu (major); Zn (occurrence).
Ore Materials: Cu carbonate, cuprite, pyrite, chalcopyrite and sphalerite.

Sec. 11, T2S, R14E.

Commodities: W (major); Mo (potential); Au, Ag, Pb (occurrence).
Ore Materials: Wolframite, gold, galena, silver, pyrite, molybdenite.

Deposit Description:
Small, striking N30°E, dipping 80°NW, linear shaped in a vein type deposit, underground workings. Mineralization in Precambrian Pinal Schist associated with early Tertiary granodiorite; the vein matter is chiefly quartz and coarsely granular pyrite.

Geology:

Production: Yes, small amount.
Reference: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 480, p. 1303-1305.

19. Bobtail Mine

Synonym Name: Marjana
Location: 33°16'22"N, 110°51'48"W
Sec. 12, T2S, R14E.

Commodities: Au, Ag, Cu (major); W (minor); Pb, Zn (occurrence).
Ore Materials: Huebnerite, scheelite, gold, silver, chalcopyrite, pyrite, galena and sphalerite.

Deposit Description:
Small, N55°E striking, dipping 82°NW, the form pinches and swells in a lense-type deposit, underground workings.

Geology: Mineralization in Precambrian Pinal Schist associated with early Tertiary granite, diorite and diabase.

Production: Yes, small amount.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 481, p. 1306-1308; Stipp et al., 1967.

20. Columbia Mine

Location: 33°8'36"N, 110°51'46"W
Sec. 25, T3S, R14E.

Commodities: Cu (major); Ag, Au (minor).
Ore Materials: Cu carbonates, cuprite, pyrite and chalcopyrite.
Deposit Description:
Small, striking N89°E, dipping 75°S, linear shaped in a vein, underground workings.

Geology: Mineralization in Precambrian limestone associated with early Tertiary quartz diorite porphyry; heavy complex faulting is present.

Production: Yes, small amount.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 480, p. 1330-1332; Stipp et al., 1967.

21. Dripping Springs Mine

Synonym Name: Columbia.
Location: 33°8'36"N, 110°51'46"W
Sec. 25, T3S, R14E.

Commodities: Cu (major); Zn (occurrence).
Ore Materials: Cu carbonate, cuprite, pyrite, chalcopyrite and sphalerite.

Deposit Description:
Small, striking N87°E, dipping 80°S, linear form in a vein type deposit, underground workings.
Geology: Mineralization in Precambrian Mescal Limestone associated with early Tertiary quartz diorite porphyry and granodiorite.
Production: Yes, small amount.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 491, p. 1333-1335; Stipp et al., 1967.

22. **Barbarossa Placer**
Location: 33°07'36"N, 110°51'52"W
Sec. 36, T3S, R14E.
Commodity: Au.
Ore Material: Gold.
Deposit Description:
Small, placer, surface workings.
Geology: Mineralization in Quaternary soil and loose detritus.
Production: Yes, small amount.
Reference: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 492, p. 1336-1337.

23. **Elephant Butte Group**
Location: Sec. 24, T1S, R10E.
Commodities: W (major); Mo (occurrence).
Ore Materials: Scheelite (Mo bearing).
Deposit Description:
Small, striking N50°E, dipping 75°NW, ore in discontinuous parallel veins, conformable to the bedding cleavage, surface and underground workings.
Geology: Mineralization in early Precambrian Schist.
Production: Yes, small amount, 5 tons.
References: U.S.G.S., 1981, CRIB Mineral Resources File 12, Record 1701, p. 4374-4376; Stipp et al., 1967.

25. **Silver King Mine**
Location: 33°19'50"N, 111°05'15"W
Sec. 24, T1S, R12E.
Commodities: Ag (major); Pb, Zn, Cu (occurrence).
Ore Materials: Cerargyrite, argentite, native silver; galena, sphalerite, chalcopyrite, tetrahedrite, bornite, chalcocite, covellite, cuprite, azurite, malachite, native gold.
Deposit Description:
Small, dipping 70°W; cylindrical, columnar shaped in veins, lower ore grade with depth.
Geology: Mineralization in Cretaceous quartz diorite porphyry; NW trending faults, ore in porphyry penetrated with quartz veinlets, masses and bunches of ore.
Production: Yes, currently producing.
References: U.S.G.S., 1981, CRIB Mineral Resources File 12, Record 1703, p. 4379-4381; Arizona Bureau of Mines, 1969; Arizona Department of Mineral Resources, 1981.

Deposit Description:
Small, striking N82°E, dipping 80°S, lenses
Geology: Mineralization in Precambrian Mescal Limestone associated with early Tertiary quartz diorite porphyry and granodiorite.
Production: Yes, small amount.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 491, p. 1333-1335; Stipp et al., 1957.

22. Bordeaux Placer
Location: 33°07'36"N, 110°51'52"W
Sec. 36, T3S, R14E.
Commodity: Au.
Ore Material: Gold.
Deposit Description:
Small, placer, surface workings.
Geology: Mineralization in Quaternary sand and loose detritus.
Production: Yes, small amount.
Reference: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 492, p. 1336-1337.

23. Elephant Butte Group
Location: Sec. 24, T1S, R10E.
Commodities: U (major); Mo (occurrence).
Ore Materials: Scheelite (Mo bearing).
Deposit Description:
Small, striking N50°E, dipping 71°NW, ore in discontinuous parallel veins, conformable to the bedding cleavage, surface and underground workings.
Geology: Mineralization in early Precambrian Schist.
Production: Yes, small amount, 5 tons.
References: U.S.G.S., 1981, CRIB Mineral Resources File 12, Record 1701, p. 4374-4376; Stipp et al., 1957.

25. Silver King Mine
Location: 33°19'50"N, 111°05'15"W
Sec. 24, T1S, R12E.
Commodities: Ag (major); Pb, Zn, Cu (occurrence).
Ore Materials: Cerargyrite, argentite, native silver; galena, sphalerite, chalcopyrite, tetrahedrite, bornite, chalcocite, covellite, cuprite, azurite, malachite, native gold.
Deposit Description:
Small, dipping 70°W; cylindrical, columnar shaped in veins, lower ore grade with depth.
Geology: Mineralization in Cretaceous quartz diorite porphyry; NW trending faults, ore in porphyry penetrated with quartz veinlets, masses and bunches of ore.
Production: Yes, currently producing.
References: U.S.G.S., 1981, CRIB Mineral Resources File 12, Record 1703, p. 4379-4381; Arizona Bureau of Mines, 1929; Arizona Department of Mineral Resources, 1981.

26. **Magma Mine**

Synonym Name: Silver Queen, Hub Claim, Irene Claim, Monarch Claim.
Location: 33°18'21"N, 111°05'29"W
Sec. 25, 26, 35, 36, T1S, R12E.
Commodities: Cu, Ag, Au, Zn (major); Mn (potential); Pb, Se, As, Sb (occurrence).
Ore Materials: Bornite, chalcocite, chalcopyrite, pyrite, tennantite, malachite, cuprite,native copper, enargite, stromeyerite, native silver, native gold, smithsonite, hydrozincite, hemimorphite, sphalerite, galena, coronadite, Mn oxides.
Deposit Description:
Trending S80°W, dipping 70° to 80°N, vein type, underground workings.
Geology: Mineralization in Precambrian-Tertiary quartz porphyry dike, diabase, basalt, shale, conglomerate and quartzite; ore is not continuous throughout the length and depth but consists of several distinct shoots separated by barren vein material. Ore bodies in two fault zones, the Magma fault and the Koerner fault. There are four main ore bodies. Mn Oxides containing Ag occur in limestone and quartzite, in lenses and masses up to 3 feet wide.
Production: Yes, currently producing.
References: U.S.G.S., 1981, CRIB Mineral Resources File 12, Record 1704, p. 4382-4385; Stipp et al., 1967; Arizona Bureau of Mines, 1969; Arizona Dept. of Mineral Resources, 1981.

27. **Lake Superior and Arizona Mine**

Synonym Names: Gold Eagle, L.S. and A.
Location: Sec. 35, T1S, R12E.
Commodities: Au, Cu (major); Ag (minor).
Ore Materials: Native gold, malachite, chrysocolla, chalcocite, native silver, Mn oxides.
Deposit Description:
Small, trending N, dipping 30°E, vein type deposit, most productive gold horizon along the faults is within the limestone, 10-20 feet above the limestone-quartzite contact, underground workings.
Geology: Mineralization in Cambrian quartzite and Devonian limestone, vein occurs within a strike fault zone that has brecciated the wall rock contact and the lower beds of the limestone.
Production: Yes, small amount.
Reference: U.S.G.S., 1981, CRIB Mineral Resources File 12, Record 1705, p. 4386-4388.

28. **Rainbow Group**

Location: 33°21'36"N, 110°59'21"W
Sec. 12, T1S, R13E.
Commodities: W (major); Cu (minor); Mo (occurrence).
Ore Materials: Wolframite, scheelite, chalcopyrite, bornite, molybdenite.

26. Magma Mine
Synonym Name: Silver Queen, Mug Claim, Irene Claim, Monarch Claim
Location: 33°18'21"N, 111°05'29"W
Sec. 25, 26, 35, 36, T1S, R12E.
Commodities: Cu, Ag, Au, Zn (major); Mn (potential); Pb, Se, As, Sb (occurrence).
Ore Materials: Bornite, chalcocite, chalcopyrite, pyrite, tennantite, malachite, cuprite, native copper, enargite, stromeyerite, native silver, native gold, smithsonite, hydrozincite, hemimorphite, sphalerite, galena, coronadite, Mn oxides.
Deposit Description:
Trending 580°W, dipping 70° to 90°N, vein type, underground workings.
Geology: Mineralization in Precambrian-Tertiary quartz porphyry dike, diabase, basalt, shale, conglomerate and quartzite; ore is not continuous through the length and depth but consists of several distinct shoots separated by barren vein material. Ore bodies in two fault zones, the Magma fault and the Keweenaw fault. There are four main ore bodies. Mn Oxides containing Ag occur in limestone and quartzite, in lenses and masses up to 3 feet wide.
Production: Yes, currently producing.
References: U.S.G.S., 1981, CRIB Mineral Resources File 12, Record 1704, p. 4382-4385; Stipp et al., 1967; Arizona Bureau of Mines, 1959; Arizona Dept. of Mineral Resources, 1981.

27. Lake Superior and Arizona Mine
Synonym Names: Gold Eagle, L.S. and A.
Location: Sec. 35, T1S, R12E.
Commodities: Au, Cu (major); Ag (minor).
Ore Materials: Native gold, malachite, chrysocolla, chalcocite, native silver, Mn oxides.
Deposit Description:
Small, trending N, dipping 70°E, vein type deposit, most productive gold horizon along the fault is within the limestone, 10-20 feet above the limestone-quartzite contact, underground workings.
Geology: Mineralization in Cambrian quartzite and Devonian limestone, vein occurs within a strike fault zone that has brecciated the wall rock contact and the lower beds of the limestone.
Production: Yes, small amount.
Reference: U.S.G.S., 1981, CRIB Mineral Resources File 12, Record 1705, p. 4386-4388.

28. Rainbow Group
Location: 33°21'36"N, 110°59'21"W
Sec. 12, T1S, R12E.
Commodities: W (major); Cu (minor); Mo (occurrence).
Ore Materials: Hoffmanite, scheelite, chalcopyrite, bornite, molybdenite.

Deposit Description:
Small, trending N70°E to N45°E, dipping steeply to the NW, vein, surface and underground workings.
Geology: Mineralization in early Tertiary quartz monzonite.
Production: Yes, 114 tons.
References: U.S.G.S., 1981, CRIB Mineral Resources File 12, Record 1706, p. 4389-4391.

30. **Swede Mine and Clark Prospect**
Synonym Name: Cole Tungsten Prospect, Old Swede Mine.
Location: 33°21'36"N, 110°59'21"W
Sec. 12, T1S, R13E.
Commodities: W (major); Mo (occurrence).
Ore Materials: Wolframite, scheelite; molybdenite.
Deposit Description:
Small, trending N30° to N35°E, dipping 65°SE, vein/fissure type deposit; most of the wolframite is south of the fault, confined to a ten inch streak on the hanging wall at the surface and on the footwall in the adit crosscut, surface and underground workings.
Geology: Mineralization in Precambrian schist, and in early Tertiary granite porphyry dikes; the shear zone is intersected by two narrow dikes (Swede vein); Swede vein transverses an irregular tongue of schist projecting into the granite, along a shear zone slightly discordant with the schist bedding. Replacement by vein matter is most complete where shear zone is intersected by the granite porphyry dikes.
Production: Yes, small amount.
References: U.S.G.S., 1981, CRIB Mineral Resources File 12, Record 1708, p. 4394-4396; Stipp et al., 1967.

31. **American Mine**
Location: 33°19'58"N, 110°58'35"W
Sec. 24, T1S, R13E,
Sec. 19, T1S, R14E.
Commodities: Cu (major); Ag, Au (minor).
Ore Materials: Chalcopyrite, tetrahedrite-tennantite.
Deposit Description:
Small, trending N43°E, dipping 55°NW to vertical, vein type deposit, underground workings.
Geology: Mineralization in early Tertiary granite (porphyritic biotite-quartz monzonite): vein is a composite of small discontinuous stringers of quartz, pyrite, and chalcopyrite, from three inches to three feet wide. Ore shoot contains tetrahedrite-tennantite, pyrite, and chalcopyrite. Mine is in the southern end of the Schutze Granite near schist contact.
Production: Yes, small amount.
References: U.S.G.S., 1981, CRIB Mineral Resources File 12, Record 1709, p. 4397-4399; Stipp et al., 1967.

Deposit Description:
Small, trending N10°E to W45°E, dipping steeply to the NW. Vein, surface and underground workings.

Geology: Mineralization in early Tertiary quartz monzonite.
Production: Yes, 114 tons.
References: U.S.G.S., 1981, CRIB Mineral Resources File 12, Record 1706, p. 4389-4391.

30. Swede Mine and Clark Prospect
Synonym Name: Cole Tungsten Prospect, Old Swede Mine.
Location: 33°21'36"N, 110°59'21"W
Sec. 12, T15, R13E.

Commodities: W (major); Mo (occurrence).
Ore Materials: Wolframite, scheelite; molybdenite.
Deposit Description:
Small, trending N30° to N45°E, dipping 65°SE, vein/fissure type deposit; most of the wolframite is south of the fault, confined to a ten inch streak on the hanging wall at the surface and on the footwall in the adit crosscut, surface and underground workings.

Geology: Mineralization in Precambrian schist, and in early Tertiary granite porphyry dikes; the shear zone is intersected by two narrow dikes (Swede vein); Swede vein transverses an irregular tongue of schist projecting into the granite, along a shear zone slightly discordant with the schist bedding. Displacement by vein matter is most complete where shear zone is intersected by the granite porphyry dikes.

Production: Yes, small amount.
References: U.S.G.S., 1981, CRIB Mineral Resources File 12, Records 1706, p. 4394-4396; Stipp et al., 1967.

31. American Mine
Location: 33°19'58"N, 110°58'35"W
Sec. 24, T15, R13E.
Sec. 19, T15, R14E.

Commodities: Cu (major); Ag, Au (minor).
Ore Materials: Chalcopyrite, tetrahedrite-tennantite.
Deposit Description:
Small, trending N43°E, dipping 55°NW to vertical, vein type deposit, underground workings.

Geology: Mineralization in early Tertiary granite (porphyritic biotite-quartz monzonite): vein is a composite of small discontinuous stringers of quartz, pyrite, and chalcopyrite, from three inches to three feet wide. Ore shoot contains tetrahedrite-tennantite, pyrite, and chalcopyrite. Mine is in the southern end of the Schultze Granite near schist contact.

Production: Yes, small amount.
References: U.S.G.S., 1981, CRIB Mineral Resources File 12, Record 1706, p. 4397-4399; Stipp et al., 1967.

32. **Queen Creek Mine**
Location: 33°14'24"N, 111°05'09"W
Sec. 2, T2S, R12E.
Commodities: Au, Ag (major); Cu (minor).
Ore Materials: Native gold, free silver, malachite and chrysocolla.
Deposit description:
Small, trending N, dipping 30°E, vein type deposit; best and largest ore shoots are in the hanging wall of the vein, underground workings.
Geology: Mineralization in Cambrian quartzite and Devonian limestone.
Production: Yes, small amount.
References: U.S.G.S., 1981, CRIB Mineral Resources File 12, Record 1710, p. 4400-4402; Stipp et al., 1967.

33. **Belmont Mine**
Synonym Names: Smith Lease, Monte Carlo Claim
Location: 33°16'19"N, 111°04'31"W
Sec. 12, T2S, R12E.
Commodities: Ag, Cu, Au (major); Pb, Zn (minor); V (occurrence).
Ore Materials: Native silver, argentite, cerargyrite, native gold, chalcopyrite, sphalerite, galena, vanadate.
Deposit Description:
Small trending N-NW, dipping 30°E, lenticular shape in a fissure vein, underground workings.
Geology: Mineralization in Precambrian diabase, and lower Precambrian limestone.
Production: Yes, small amount.
References: U.S.G.S., 1981, CRIB Mineral Resources File 12, Record 1711, p. 4403-4405; Stipp et al., 1967; Arizona Bureau of Mines, 1969.

35. **Rainbow Silver Mine**
Location: Sec. 27, T3S, R11E.
Commodities: Ag, Cu.
Ore Materials: Galena, chalcopyrite and tetrahedrite.
Deposit Description:
Vein.
Geology: Mineralization in Precambrian schist, diabase dike.
Production: Yes, small amount.
References: U.S.G.S., 1977, CRIB Mineral Resources File 12, Record 1714, p. 4409-4410.

38. **Ray Mine**
Location: 33°10'26"N, 110°59'31"W
Sec. 14, 15, 10, T3S, R13E.
Commodities: Cu (major); Au, Ag (minor); Mo (occurrence).
Ore Materials: Chalcopyrite, unknown gold and silver, pyrite, molybdenite.
Deposit Description:
Large, irregularly shaped in a disseminated type deposit, surface and underground workings.
Geology: Mineralization in Precambrian schist associated with Tertiary diabase; mineralized area bound by the west end fault, the broken hill fault, and the north end

32. Queen Creek Mine
Location: 33°14'24"N, 111°05'09"W
Sec. 2, T2S, R12E.
Commodities: Au, Ag (major); Cu (minor).
Ore Materials: Native gold, free silver, malachite and chrysocolla.
Deposit description:
Small, trending N, dipping 30°E, vein type deposit; best and largest ore shoots are in the hanging wall of the vein, underground workings.
Geology: Mineralization in Cambrian quartzite and Devonian limestone.
Production: Yes, small amount.
References: U.S.G.S., 1981, CRIB Mineral Resources File 12; Record 1710, p. 4400-4402; Stipp et al., 1967.

33. Belmont Mine
Synonym Names: Smith Lease, Mogie Carlo Claim
Location: 33°16'19"N, 111°04'31"W
Sec. 12, T2S, R12E.
Commodities: Ag, Cu, Au (major); Pb, Zn (minor); V (occurrence).
Ore Materials: Native silver, argentite, cerargyrite, native gold, chalcopyrite, sphalerite, galena, vanadate.
Deposit Description:
Small trending N-NW, dipping 30°E, lenticular shape in a fissure vein, underground workings.
Geology: Mineralization in Precambrian diabase, and lower Precambrian limestone.
Production: Yes, small amount
References: U.S.G.S., 1981, CRIB Mineral Resources File 12; Record 1711, p. 4403-4405; Stipp et al., 1967; Arizona Bureau of Mines, 1959.

35. Rainbow Silver Mine
Location: Sec. 27, T3S, R11E.
Commodities: Ag, Cu.
Ore Materials: Galena, chalcopyrite and tetrahedrite.
Deposit Description:
Vein.
Geology: Mineralization in Precambrian schist, diabase dike.
Production: Yes, small amount.
References: U.S.G.S., 1977, CRIB Mineral Resources File 12; Record 1716, p. 4409-4410.

36. Ray Mine
Location: 33°10'26"N, 110°59'31"W
Sec. 14, 15, 10, T3S, R13E.
Commodities: Cu (major); Au, Ag (minor); Mo (occurrence).
Ore Materials: Chalcopyrite, unknown gold and silver, pyrite, molybdenite.
Deposit Description:
Large, irregularly shaped in a disseminated type deposit, surface and underground workings.
Geology: Mineralization in Precambrian schist associated with Tertiary diabase; mineralized area bound by the west end fault, the broken Hill fault, and the north end

fault, and less sharply by the granite and schist contact. Ore also affected by the Pinal Schist foliation.
Production: Yes, large amount, currently in production.
References: U.S.G.S., 1981, CRIB Mineral Resources File 12, Record 1717, p. 4415-4418; Stipp et al., 1967; Arizona Bureau of Mines, 1969; Arizona Department of Mineral Resources, 1981.

45. **Wooley No. 1 Claim**
Location: 33°02'39"N, 111°01'36"W
Sec. 33, T4S, R13E.
Commodities: Cu, Ag (potential); U (occurrence).
Ore Materials: Unknown uranium; malachite, chalcopyrite, chalcocite, chrysocolla.
Deposit Description:
Small, trending N63° to 85°E, dipping 70° to 90°SE, vein type deposit.
Geology: Rhyodacite dikes cutting Precambrian granite.
Production: Yes, Cu production.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 1724, p. 4432-4433; Stipp et al., 1967; Peirce et al., 1970; Luning et al., 1982.

46. **Snow White Perlite**
Location: Sec. 25, T1S, R11E.
Commodity: perlite.
Production: Yes.
References: U.S.G.S., 1972, CRIB Mineral Resources File 12, Record 1848, p. 4722; Arizona Bureau of Mines, 1969.

49. **Chemi-cote Chem. Co.**
Synonym Names: Chicago Pit, Old Cliff.
Location: Sec. 3, 9, 15, 16, T2S, R12E.
Commodity: Perlite.
Geology: Perlite outcrops over extensive area, 5-10 feet thick.
Production: Currently producing.
References: U.S.G.S., 1972, CRIB Mineral Resources File 12, Record 1899, p. 4831; Arizona Department of Mineral Resources, 1981.

70. **Perlite Pit**
Synonym Name: Guzman Construction.
Location: Sec. 5, T2S, R12E.
Commodity: Perlite.
Production: Currently producing.
References: McCrory and O'Haire, 1965; Arizona Department of Mineral Resources, 1981.

133. **Silver Bell**
Synonym Name: Martinez.
Location: Sec. 17, T3S, R11E.
Commodities: Pb, Ag, Cu, Au, Zn.
Deposit Description:

fault, and less sharply by the granite and schist contact. Ore also affected by the final schist foliation.

Production: Yes, large amount, currently in production.

References: U.S.G.S., 1981, CRIB Mineral Resources File 12, Record 1717, p. 4415-4418; Stipp et al., 1957; Arizona Bureau of Mines, 1959; Arizona Department of Mineral Resources, 1981.

45. Money No. 1 Claim

Location: 32°02'39"N, 111°01'36"W
Sec. 33, T4S, R13E.

Commodities: Cu, Ag (potential); U (occurrence).

Ore Materials: Unknown uranium; malachite, chalcopyrite, chalcocite, chrysocolla.

Deposit Description:
Small, trending N63° to 85°E, dipping 70° to 90°SE, vein type deposit.

Geology: Rhyodacite dikes cutting Precambrian granite.

Production: Yes, Cu production.

References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 1724, p. 4432-4433; Stipp et al., 1957; Peirce et al., 1970; Luning et al., 1982.

46. Snow White Perlite

Location: Sec. 25, T1S, R11E.

Commodity: perlite.

Production: Yes.

References: U.S.G.S., 1972, CRIB Mineral Resources File 12, Record 1869, p. 4722; Arizona Bureau of Mines, 1959.

47. Chandler-Cole Co.

Synonym Names: Chicago Pit, Old Cliff.

Location: Sec. 3, 9, 15, 16, T2S, R12E.

Commodity: Perlite.

Geology: Perlite outcrops over extensive area, 5-10 feet thick.

Production: Currently producing.

References: U.S.G.S., 1972, CRIB Mineral Resources File 12, Record 1859, p. 4531; Arizona Department of Mineral Resources, 1981.

70. Perlite Pit

Synonym Name: Hacman Construction.

Location: Sec. 6, T2S, R12E.

Commodity: Perlite.

Production: Currently producing.

References: McCrory and O'Haire, 1965; Arizona Department of Mineral Resources, 1981.

123. Silver Bell

Synonym Name: Martinez.

Location: Sec. 17, T3S, R11E.

Commodities: Pb, Ag, Cu, Au, Zn.

Deposit Description:

Mineralization in fault zone.
Geology: In fault cutting Precambrian granite and schist.
Production: Yes, small amount.
References: Stipp et al., 1967; Arizona Bureau of Mines, 1969.

143. **Copper Butte Mine**
Location: Sec. 19, 30, T3S, R13E.
Commodities: Cu (major); Ag (occurrence).
Ore Materials: Cu sulfides and oxides.
Deposit Description/Geology:
Mineralization in Pinal Schist and Whitetail Conglomerate.
Production: Some 200,000 tons of copper ore.
References: Stipp et al., 1967; Kennecott, written communication.

166. **Unnamed Marekanite Occurrence**
Location: Sec. 1, T2S, R11E (location approximate).
Commodities: Marekanite (apache tears).
Geology: In Tertiary perlitic volcanic rocks.
Production: Yes, small amount.
Referenes: Arizona Bureau of Mines, 1969.

167. **McNeice Stone Works**
Location: Sec. 28, 33, T1N, R11E (location approximate).
Commodities: Marble for building stone.
Deposit Description:
Marmorized and serpentinized Mescal Limestone.
Production: Yes.
References: Arizona Bureau of Mines, 1969.

168. **Kearney Sand and Gravel**
Location: Sec. 34, T3S, R14E (location approximate).
Commodities: Sand and gravel.
Production: Yes, less than 50,000 tons.
References: Arizona Bureau of Mines, 1969.

169. **Superior Sand and Gravel**
Location: Sec. 30, T1N, R13E (location approximate).
Commodities: Sand and gravel.
Production: Yes, less than 50,000 tons.
References: Arizona Bureau of Mines, 1969.

170. **Globe-Miami District Gold Placers**
Location: T1N, R14E (location approximate, placed in richest part of district).
Commodities: Au.
Deposit Description:
Placer.
Production: Yes, less than 10,000 oz.
References: Johnson, 1972.

171. **Mineral Creek District Gold Placers**
Location: Sec. 25, T2S, R13E.
Commodities: Au.

Mineralization in fault zone.
Geology: In fault cutting Precambrian granite and schist.
Production: Yes, small amount.
References: Stipp et al., 1967; Arizona Bureau of Mines, 1969.

142. Copper Butte Mine
Location: Sec. 19, 20, T3S, R13E.
Commodities: Cu (major); Ag (occurrence).
Ore Materials: Cu sulfides and oxides.
Deposit Description/Geology:
Mineralization in Pinal Schist and Whitetail Conglomerate.
Production: Some 200,000 tons of copper ore.
References: Stipp et al., 1967; Kennecott, written communication.

160. Unnamed Marekanite Occurrence
Location: Sec. 1, T2S, R11E (location approximate).
Commodities: Marekanite (apache tears).
Geology: In Tertiary perlitic volcanic rocks.
Production: Yes, small amount.
References: Arizona Bureau of Mines, 1969.

167. McKelce Stone Work
Location: Sec. 28, 33, T1N, R11E (location approximate).
Commodities: Marble for building stone.
Deposit Description:
Metamorphosed and serpentinized Mescal Limestone.
Production: Yes.
References: Arizona Bureau of Mines, 1969.

169. Kyarsky Sand and Gravel
Location: Sec. 34, T3S, R14E (location approximate).
Commodities: Sand and gravel.
Production: Yes, less than 50,000 tons.
References: Arizona Bureau of Mines, 1969.

169. Superior Sand and Gravel
Location: Sec. 32, T1N, R12E (location approximate).
Commodities: Sand and gravel.
Production: Yes, less than 50,000 tons.
References: Arizona Bureau of Mines, 1969.

170. Globe-Miami District Gold Placers
Location: T1N, R14E (location approximate; placed in richest part of district).
Commodities: Au.
Deposit Description:
Placer.
Production: Yes, less than 10,000 oz.
References: Johnson, 1972.

171. Mineral Creek District Gold Placers
Location: Sec. 26, T2S, R13E.
Commodities: Au.

Deposit Description:
Placer.
Production: Yes, less than 380 oz.
References: Johnson, 1972.

178. **Superior Mine**
Location: SW 1/4 Sec. 5, T2S, R12E.
Commodity: Perlite.
Production: Currently producing.
Reference: Arizona Department of Mineral Resources, 1981.

Known Prospects, Mineralized Areas, and Geothermal Resources with No Recorded Production

2. **Crown Point No. 6 Claim**
Location: 33°23'32"N, 110°59'09"W
Sec. 36, T1N, R13E.
Commodities: Cu, W (major); V, Pb (minor).
Ore Materials: Cerussite, wulfenite, vanadinite and galena.
Deposit Description:
Small, N 60°E striking, dipping 50°SE, linear in a vein replacement.
Geology: Mineralization in Precambrian diabase associated with early Tertiary Schultze Granite is limited to a small fracture; a fault along the east side of the outcrop brings the diabase into contact with the Pinal Schist of a thrust plate overlying diabase and Whitetail Conglomerate.
Production: None.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 398, p. 1075-1076; Stipp et al., 1967; Arizona Bureau of Mines, 1969.

3. **Cactus Mine**
Location: 33°23'06"N, 110°58'54"W
Sec. 36, T1N, R13E.
Commodity: Cu, U (occurrence).
Ore Materials: Chalcocite, copper carbonates and pyrite.
Deposit Description:
Small, dipping 40°W, underground workings.
Geology: Mineralization in Precambrian Pinal Schist associated with early Tertiary Schultze Granite; the east boundary between mineralized and unmineralized schist is largely covered by talus, but in the few places where it can be seen, it is marked by a zone of intense brecciation that probably is the outcrop of the Cactus fault, the most metalized rock is generally in the lower part of the deposit, just above the Cactus fault, which itself is richly metalized with copper carbonates and silicates that coat breccia fragments or fill interstices between them; much of the oxidation, leaching, and deposition of copper carbonates and silicates was accomplished during the present cycle of erosion

Deposit Description:
Placer.
Production: Yes, less than 380 oz.
References: Johnson, 1972; [illegible]

110. Superior Mine
Location: SW 1/4 Sec. 5, T2S, R12E.
Commodity: Perlite.
Production: Currently producing.
References: Arizona Department of Mineral Resources, 1981.

Known Prospects, Mineralized Areas, and Geothermal Resources with No Recorded Production

2. Crown Point No. 6 Claim
Location: 33°23'32"N, 110°59'09"W
Sec. 36, T1N, R13E.
Commodities: Cu, W (major); V, Pb (minor).
Ore Materials: Carrasite, wulfenite, vanadinite and galena.
Deposit Description:
Small, N 60°E striking, dipping 50°SE, linear in a vein replacement.
Geology: Mineralization in Precambrian diabase associated with early Tertiary Schultze Granite is limited to a small fracture; a fault along the east side of the outcrop brings the diabase into contact with the Paint Schist of a thrust plate overlying diabase and Whitetail Conglomerate.
Production: None.
References: U.S.G.S., 1979, Crib Mineral Resources File 12, Record 398, p. 1075-1076; Stipp et al., 1967; Arizona Bureau of Mines, 1969.

3. Cactus Mine
Location: 33°23'06"N, 110°58'54"W
Sec. 36, T1N, R13E.
Commodity: Cu, W (occurrence).
Ore Materials: Chalcocite, copper carbonates and pyrite.
Deposit Description:
Small, dipping 40°W, underground workings.
Geology: Mineralization in Precambrian Pinal Schist associated with early Tertiary Schultze Granite; the east boundary between mineralized and unmineralized schist is largely covered by talus, but in the few places where it can be seen, it is marked by a zone of intense brecciation that probably is the outcrop of the Cactus fault, the most mineralized rock is generally in the lower part of the deposit, just above the Cactus fault, which itself is richly mineralized with copper carbonates and silicates that coat breccia fragments or fill interstices between them; much of the oxidation, leaching, and deposition of copper carbonates and silicates was accomplished during the present cycle of erosion

after the plate had been thrust to its present position.
Production: None.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 396, p. 1069-1071; Luning et al., 1982.

4. **Fern Magnetite Prospect**
Location: 33°27'54"N, 110°57'56"W
Sec. 6, T1N, R14E.
Commodity: Fe.
Ore Material: Magnetite.
Deposit Description:
Small, dipping 25°N, irregularly shaped in a replacement.
Geology: The magnetite occurs as nearly pure masses, as bands partially replacing Precambrian Mescal Limestone, and as disseminations, associated with nearby Precambrian diabase intrusives.
Production: None.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 399, p. 1077-1078.

11. **Bronx Mine**
Location: 33°21'58"N, 110°58'34"W
Sec. 6, T1S, R14E.
Commodities: Mo (main); Cu (occurrence).
Ore Materials: Molybdenite, pyrite, chalcopyrite and chalcocite.
Deposit description:
Small, striking NE, dipping 80°SE, linear shaped in a replacement.
Geology: Mineralization in early Tertiary Schultze Granite; the veins are widest and most strongly mineralized near the bottom of the canyon, suggesting that the outcrops are near the upper limits at which mineralization occurred; the origin of the quartz-muscovite veinlets is not understood, but their uniform distribution throughout the granite mass suggests that they were deposited by solutions that emanated from the granite itself during the final stages of solidification.
Production: None.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 457, p. 1242-1244; Stipp et al., 1967.

13. **Madera Prospect**
Location: 33°19'58"N, 110°53'35"W
Sec. 24, T1S, R14E.
Commodity: Cu.
Ore Materials: Copper sulfate, chalcocite, and chalcopyrite.
Deposit Description:
Small, irregularly shaped in a disseminated deposit.
Geology: Mineralization in Precambrian Pinal Schist, associated with early Tertiary Schultze Granite.
Production: None.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12,

after the plate had been thrust to its present position.

Production: None.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 296, p. 1069-1071; Lanting et al., 1982.

4. Fern Magnetite Prospect

Location: 33°27'54"N, 110°57'56"W
Sec. 6, T1N, R14E.

Commodity: Fe.
Ore Material: Magnetite.
Deposit Description:
Small, dipping 25°N, irregularly shaped in a replacement.

Geology: The magnetite occurs as nearly pure masses, as bands partially replacing Precambrian Mescal Limestone, and as disseminations, associated with nearby Precambrian diabase intrusives.

Production: None.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 299, p. 1077-1078.

11. Bronx Mine

Location: 33°21'58"N, 110°59'34"W
Sec. 6, T1S, R14E.

Commodities: Mo (main); Cu (occurrence).
Ore Materials: Molybdenite, pyrite, chalcopyrite and chalcocite.
Deposit description:
Small, striking NE, dipping 80°SE, linear shaped in a replacement.

Geology: Mineralization in early Tertiary Schultze Granite; the veins are widest and most strongly mineralized near the bottom of the canyon, suggesting that the outcrops are near the upper limits at which mineralization occurred; the origin of the quartz-muscovite veinlets is not understood, but their uniform distribution throughout the granite mass suggests that they were deposited by solutions that emanated from the granite itself during the final stages of solidification.

Production: None.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 457, p. 1242-1244; Stipp et al., 1967.

12. Madera Prospect

Location: 33°19'58"N, 110°53'35"W
Sec. 24, T1S, R14E.

Commodity: Cu.
Ore Materials: Copper sulfate, chalcocite, and chalcopyrite.
Deposit Description:
Small, irregularly shaped in a disseminated deposit.

Geology: Mineralization in Precambrian Pinal Schist, associated with early Tertiary Schultze Granite.

Production: None.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12.

Record 459, p. 1248-1249; Stipp et al., 1967.

16. **Shackelford Prospect**
Location: 33°28'42"N, 111°01'37"W
Sec. 32, T2N, R13E.
Commodity: Asbestos.
Ore Materials: Chrysotile.
Deposit Description:
Small, linear shaped deposit in veinlets.
Geology: Mineralization in Precambrian Mescal Limestone associated with Precambrian diabase.
Production: None.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 467, p. 1269-1270; Stipp et al., 1967.

17. **Chuckwalla Claims**
Location: 33°28'27"N, 110°54'47"W
Sec. 34, T2N, R14E.
Commodity: Asbestos.
Ore Materials: Chrysotile.
Deposit Description:
Small, linear shaped, vein deposit.
Geology: Mineralization in Precambrian Mescal Limestone associated with Precambrian diabase.
Production: None.
Reference: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 469, p. 1274-1275.

24. **Whetrocks, Elephant Co. Copper-Tungsten**
Location: 33°32'45"N, 111°13'15"W
Sec. 7, T1S, R11E.
Commodities: Cu, W, Pb, Zn.
Ore Materials: Malachite, azurite and chrysocolla.
Deposit Description:
Vein type.
Geology: Precambrian Pinal Schist intruded by diabase sills and dikes.
Production: None.
References: U.S.G.S., 1977, CRIB Mineral Resources File 12, Record 1702, p. 4377-4378; Stipp et al., 1967.

29. **Gabitsch-Owens Tungsten Group**
Location: Sec. 12, T1S, R13E.
Commodity: W.
Ore Materials: Wolframite, scheelite.
Deposit Description:
Small, trending N25° to 35°E, dipping 62°NW, vein, one enriched zone formed at the intersection of the vein and a quartz filled fracture, surface and underground workings.
Geology: Mineralization in early Tertiary monzonite.
Production: None.
References: U.S.G.S., 1981, CRIB Mineral Resources File 12, Record 1707, p. 4392-4393.

Record 459, p. 1248-1249; Stipp et al., 1967.

16. Shackelford Prospect

Location: 33°28'42"N, 112°01'37"W
Sec. 32, T2N, R13E.

Commodity: Asbestos.
Ore Materials: Chrysotile.
Deposit Description:
Small, linear shaped deposits in veinlets.
Geology: Mineralization in Precambrian Mescal Limestone associated with Precambrian diabase.
Production: None.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 467, p. 1269-1270; Stipp et al., 1967.

17. Chuckwalla Claims

Location: 33°28'27"N, 110°54'47"W
Sec. 34, T2N, R14E.

Commodity: Asbestos.
Ore Materials: Chrysotile.
Deposit Description:
Small, linear shaped, vein deposit.
Geology: Mineralization in Precambrian Mescal Limestone associated with Precambrian diabase.
Production: None.
References: U.S.G.S., 1979, CRIB Mineral Resources File 12, Record 469, p. 1274-1275.

24. Wheatrocks, Elephant Co. Copper-Tungsten

Location: 33°32'49"N, 111°13'15"W
Sec. 7, T2S, R11E.

Commodities: Cu, W, Pb, Zn.
Ore Materials: Malachite, azurite and chrysocolla.
Deposit Description:
Vein type.
Geology: Precambrian Pinal Schist intruded by diabase sills and dikes.
Production: None.
References: U.S.G.S., 1977, CRIB Mineral Resources File 12, Record 3702, p. 4370-4371; Stipp et al., 1967.

29. Gabitech-Queens Tungsten Group

Location: Sec. 12, T1S, R13E.

Commodity: W.
Ore Materials: Wolframite, scheelite.
Deposit Description:
Small, trending N25°E on 35°E, dipping 62°NW, vein, one enriched zone formed at the intersection of the vein and a quartz filled fracture, surface and underground workings.
Geology: Mineralization in early Tertiary monzonite.
Production: None.
References: U.S.G.S., 1981, CRIB Mineral Resources File 12, Record 1707, p. 4392-4393.

34. **Herring**
Location: 33°11'13"N, 111°11'30"W
Sec. 11, T3S, R11E.
Commodity: Ag.
Production: Unknown.
References: U.S.G.S., 1972, CRIB Mineral Resources File 12, Record 1713, p. 4408.

36. **Patrick and Wells**
Location: Sec. 8, T3S, R12E.
Commodity: Cu, Ag, Au.
Geology: Copper with silver and minor amounts of gold, scant mineralization.
Production: None.
Reference: U.S.G.S., 1972, CRIB Mineral Resources File 12, Record 1715, p. 4411-4412.

37. **Apex (Bunker Hill)**
Location: Sec. 10, T3S, R13E.
Commodity: Cu.
Deposit Description:
Shear zone.
Geology: Spotted local mineralization in shear zone in quartzite.
Production: None.
References: U.S.G.S., 1972, CRIB Mineral Resources File 12, Record 1716, p. 4413-4414; Stipp et al., 1967.

39. **Ferrell**
Location: Sec. 18, T3S, R14E.
Commodities: Au, Ag.
Ore Materials: Unknown.
Deposit Description:
Quartz stringers.
Geology: Gold in quartz stringers.
Production: None.
References: U.S.G.S., 1972, CRIB Mineral Resources File 12, Record 1718, p. 4419-4420; Stipp et al., 1967.

40. **Arizona Cons. Gold and Copper Co.**
Location: Sec. 27, 28, T4S, R11E.
Commodities: Cu, Au.
Production: None.
References: U.S.G.S., 1972, CRIB Mineral Resources File 12, Record 1719, p. 4421-4422; Stipp et al., 1967.

41. **Gran Copper, Black Copper Gp.**
Location: Sec. 5, 6, T4S, R13E.
Commodity: Cu.
Ore Materials: Chalcocite, Chrysocolla.
Deposit Description:
Fracture zone, vein.
Geology: Mineralization in Precambrian granite.
Production: None.
References: U.S.G.S., 1977, CRIB Mineral Resources File 12,

34. Herring
Location: 33°21'13"N, 111°11'30"W
Sec. 14, T3S, R11E.
Commodity: Au.
Production: Unknown.
References: U.S.G.S., 1972, CRIB Mineral Resources File 12, Record 1713, p. 4608.

35. Patrick and Wells
Location: Sec. 8, T3S, R12E.
Commodity: Cu, Ag, Au.
Geology: Copper with silver and minor amounts of gold, scant mineralization.
Production: None.
References: U.S.G.S., 1972, CRIB Mineral Resources File 12, Record 1715, p. 4611-4612.

37. Agua (Quartz Hill)
Location: Sec. 10, T3S, R13E.
Commodity: Cu.
Deposit Description:
Shear zone.
Geology: Spotted local mineralization in shear zone in quartzite.
Production: None.
References: U.S.G.S., 1972, CRIB Mineral Resources File 12, Record 1716, p. 4613-4614; Stipp et al., 1967.

39. Ferrell
Location: Sec. 18, T3S, R14E.
Commodities: Au, Ag.
Ore Materials: Unknown.
Deposit Description:
Quartz stringers.
Geology: Gold in quartz stringers.
Production: None.
References: U.S.G.S., 1972, CRIB Mineral Resources File 12, Record 1718, p. 4619-4620; Stipp et al., 1967.

40. Arizona Cons. Gold and Copper Co.
Location: Sec. 27, 28, T4S, R11E.
Commodities: Cu, Au.
Production: None.
References: U.S.G.S., 1972, CRIB Mineral Resources File 12, Record 1719, p. 4621-4622; Stipp et al., 1967.

41. Gran Copper, Black Copper Gp.
Location: Sec. 5, 8, T4S, R13E.
Commodity: Cu.
Ore Materials: Chalcocite, Chrysocolla.
Deposit Description:
Fracture zone, vein.
Geology: Mineralization in Precambrian granite.
Production: None.
References: U.S.G.S., 1972, CRIB Mineral Resources File 12.

Record 1720, p. 4423-4424; Stipp et al., 1967.

42. **Impact No. 1 and R.S. Waters Claim**
Location: Sec. 6, 7, T4S, R13E.
Commodities: Au, Ag, Cu.
Ore Materials: Native Cu, chalcopyrite, gold.
Deposit Description:
Placer along Mineral Creek.
Geology: Mineralization in Quaternary sands in and along Mineral Creek.
Production: None.
References: U.S.G.S., 1977, CRIB Mineral Resources File 12, Record 1721, p. 4425-4426.

43. **Shorty Claims Nos. 1, 2, 4.**
Location: 33°05'22"N, 111°00'46"W.
Sec. 15, T4S, R13E.
Commodity: U.
Ore Materials: Unknown uranium minerals.
Deposit Description:
Small, trending N55°-85°W, N45°W, dipping vertically; 65°NE, shear zone type deposit, radioactivity associated with quartz stringers and oxides of Fe and Mn, radioactivity sporadic, surface and underground workings.
Geology: Mineralization in porphyritic coarse grained granite.
Production: None.
References: U.S.G.S., 1981, CRIB Mineral Resources File 12, Record 1722, p. 4427-4429; Stipp et al., 1967; Peirce et al., 1970.

44. **Honey Bee No. 4 Claim**
Location: 33°04'59"N, 111°01'25"W
Sec. 16, T4S, R13E.
Commodities: U, Cu.
Ore Materials: Unknown U and Cu minerals.
Deposit Description:
Small; porphyry dike is radioactive for about 200 feet, U associated with the Fe oxides; two foot zone of Fe stained rock along the hanging wall of the mafic dike is radioactive for 200 yards, unknown workings.
Geology: Mineralization in fine grained mafic dike, porphyry dike and granite.
Production: None.
References: U.S.G.S., 1981, CRIB Mineral Resources File 12, Record 1723, p. 4430-4431; Arizona Bureau of Mines, 1969; Peirce et al., 1970; Luning et al., 1982.

47. **Magmatic Copper Co.**
Synonym Name: Stacey Claims.
Location: 33°15'08"N, 111°05'23"W
Sec. 2, 11, 12, 14, T2S, R12E.
Commodity: Mn.
Ore Materials: Mn oxides.

Record 1724, p. 4423-4424; Stipp et al., 1967.

42. Impact No. 2 and R.S. Waters Claim
Location: Sec. 6, 7, T4S, R13E.
Commodities: Au, Ag, Cu.
Ore Materials: Native Cu, chalcopyrite, gold.
Deposit Description:
Placer along Mineral Creek.
Geology: Mineralization in Quaternary sands in and along Mineral Creek.
Production: None.
References: U.S.G.S., 1917, CRIB Mineral Resources File 12, Record 1721, p. 4425-4426.

43. Shorty Claims Nos. 1, 2, 4.
Location: 33°05'22"N, 111°00'46"W.
Sec. 15, T4S, R13E.
Commodity: U.
Ore Materials: Unknown uranium minerals.
Deposit Description:
Small, trending N55°-65°W, N45°W, dipping vertically; 65°NE, shear zone type deposit, radioactivity associated with quartz stringers and oxides of Fe and Mn, radioactivity sporadic, surface and underground workings.
Geology: Mineralization in porphyritic coarse grained granite.
Production: None.
References: U.S.G.S., 1951, CRIB Mineral Resources File 12, Record 1722, p. 4427-4429; Stipp et al., 1967; Peirce et al., 1970.

44. Honey Bee No. 4 Claim
Location: 33°04'59"N, 111°01'25"W
Sec. 16, T4S, R13E.
Commodities: U, Cu.
Ore Materials: Unknown U and Cu minerals.
Deposit Description:
Small; porphyry dike is radioactive for about 200 feet, U associated with the Fe oxides; two foot zone of Fe stained rock along the hanging wall of the mafic dike is radioactive for 200 yards, unknown workings.
Geology: Mineralization in fine grained mafic dike, porphyry dike and granite.
Production: None.
References: U.S.G.S., 1951, CRIB Mineral Resources File 12, Record 1723, p. 4430-4431; Arizona Bureau of Mines, 1949, Peirce et al., 1970; Lunting et al., 1962.

47. Magnetic Copper Co.
Synonym Name: Stacey Claims.
Location: 33°13'08"N, 111°06'23"W
Sec. 2, 11, 12, 13, T2S, R12E.
Commodity: Mn.
Ore Materials: Mn oxides.

Deposit Description:
Fault fissures, underground workings.
Geology: Mineralization in Devonian-Carboniferous quartzite, limestone; associated with diabase and dacite; manganese deposits in fault fissures and bedding planes in limestone adjacent to faults.
Production: None.
References: U.S.G.S., 1972, CRIB Mineral Resources File 12, Record 1898, p. 4828-4829; Stipp et al., 1967.

48. **Woodpecker**
Location: 33°12'50"N, 111°12'05"W
Sec. 35, T2S, R11E.
Commodity: Ag.
Production: Unknown.
References: U.S.G.S., 1972, CRIB Mineral Resources File 12, Record 1897, p. 4827; Stipp et al., 1967.

50. **Myres**
Location: 33°10'53"N, 111°11'33"W
Sec. 11, T3S, R11E.
Commodity: Ag.
Production: Unknown.
References: U.S.G.S., 1972, CRIB Mineral Resources File 12, Record 1903, p. 4838; Stipp et al., 1967.

51. **Cocreham (Lead Queen)**
Location: Sec. 7, T3S, R14E.
Commodities: Pb, Au, Ag.
Geology: Ore in fissure vein.
Production: None.
References: U.S.G.S., 1972, CRIB Mineral Resources File 12, Record 1904, p. 4839-4840; Stipp et al., 1967; Arizona Bureau of Mines, 1969.

52. **Unnamed Asbestos Occurrence**
Location: Sec. 21, T2N, R13E.
Commodity: Asbestos.
Production: Unknown.
Reference: McCrory and O'Haire, 1965.

53. **Unnamed Asbestos Occurrence**
Location: Sec. 1, T1N, R12E,
Sec. 6, T1N, R13E.
Commodity: Asbestos.
Production: Unknown.
References: McCrory and O'Haire, 1965; Stipp et al., 1967.

54. **Unnamed Asbestos Occurrence**
Location: Sec. 8, T1N, R13E.
Commodity: Asbestos, U.
Production: Unknown.
References: McCrory and O'Haire, 1965; Luning et al., 1982.

55. **Unnamed Asbestos Occurrence**

Deposit Description:
Fault Fissures, underground workings.
Geology:
Mineralization in Devonian-Carboniferous quartzite; limestone; associated with diabase and dacite; manganese deposits in fault fissures and bedding planes in limestone adjacent to faults.
Production:
None.
References:
U.S.G.S., 1972, CRIB Mineral Resources File 12, Record 1298, p. 4828-4829; Stipp et al., 1967.

48. Woodpecker
Location:
33°12'50"N, 111°12'05"W
Sec. 35, T2S, R11E.
Commodity:
Ag.
Production:
Unknown.
References:
U.S.G.S., 1972, CRIB Mineral Resources File 12, Record 1807, p. 4827; Stipp et al., 1967.

50. Myers
Location:
33°10'53"N, 111°11'33"W
Sec. 11, T3S, R11E.
Commodity:
Ag.
Production:
Unknown.
References:
U.S.G.S., 1972, CRIB Mineral Resources File 12, Record 1803, p. 4838; Stipp et al., 1967.

51. Cerrobaca (Lead Queen)
Location:
Sec. 7, T3S, R14E.
Commodities:
Pb, Au, Ag.
Geology:
Ore in fissure veins.
Production:
None.
References:
U.S.G.S., 1972, CRIB Mineral Resources File 12, Record 1804, p. 4839-4840; Stipp et al., 1967; Arizona Bureau of Mines, 1969.

52. Unnamed Asbestos Occurrence
Location:
Sec. 21, T2N, R13E.
Commodity:
Asbestos.
Production:
Unknown.
References:
McCrory and O'Haire, 1965.

53. Unnamed Asbestos Occurrence
Location:
Sec. 1, T1N, R12E,
Sec. 6, T1N, R13E.
Commodity:
Asbestos.
Production:
Unknown.
References:
McCrory and O'Haire, 1965; Stipp et al., 1967.

54. Unnamed Asbestos Occurrence
Location:
Sec. 8, T1N, R13E.
Commodity:
Asbestos, U.
Production:
Unknown.
References:
McCrory and O'Haire, 1965; Luning et al., 1982.

55. Unnamed Asbestos Occurrence.

Location: Sec. 7, T1N, R13E.
Commodity: Asbestos.
Production: Unknown.
References: McCrory and O'Haire, 1965; Stipp et al., 1967.

56. **Unnamed Asbestos Occurrence**
Location: Sec. 13, T1N, R12E.
Commodity: Asbestos.
Production: Unknown.
References: McCrory and O'Haire, 1965; Stipp et al., 1967.

57. **Unnamed Perlite Occurrence**
Location: Sec. 9, T1N, R12E.
Commodity: Perlite.
Production: Unknown.
References: McCrory and O'Haire, 1965.

58. **Unnamed Asbestos Occurrence**
Location: Sec. 18, T1N, R12E.
Commodity: Asbestos.
Production: Unknown.
References: McCrory and O'Haire, 1965.

59. **Unnamed Asbestos Occurrence**
Location: Sec. 19, T1N, R12E.
Commodity: Asbestos.
Production: Unknown.
References: McCrory and O'Haire, 1965; Stipp et al., 1967.

60. **Unnamed Asbestos Occurrence**
Location: Sec. 11, T1S, R11E.
Commodity: Asbestos.
Production: Unknown.
References: McCrory and O'Haire, 1965; Stipp et al., 1967.

61. **Unnamed Asbestos Occurrence**
Location: Sec. 15, T1S, R11E.
Commodity: Asbestos.
Production: Unknown.
References: McCrory and O'Haire, 1965; Stipp et al., 1967.

62. **Unnamed Asbestos Occurrence**
Location: Sec. 32, T1S, R11E.
Commodity: Asbestos.
Production: Unknown.
References: McCrory and O'Haire, 1965.

63. **Unnamed Asbestos Occurrence**
Location: Sec. 34, T2N, R14E.
Commodity: Asbestos.
Production: Unknown.
References: McCrory and O'Haire, 1965; Stipp et al., 1967.

64. **Unnamed Turquoise Occurrence**
Location: Sec. 20, .T1N, R14E.

Location: Sec. 7, T1N, R12E.
Commodity: Asbestos.
Production: Unknown.
References: McCrory and O'Haire, 1958; Stipp et al., 1967.

56. Unnamed Asbestos Occurrence
Location: Sec. 13, T1N, R12E.
Commodity: Asbestos.
Production: Unknown.
References: McCrory and O'Haire, 1965; Stipp et al., 1967.

57. Unnamed Perlite Occurrence
Location: Sec. 3, T1N, R12E.
Commodity: Perlite.
Production: Unknown.
References: McCrory and O'Haire, 1965.

58. Unnamed Asbestos Occurrence
Location: Sec. 10, T1N, R12E.
Commodity: Asbestos.
Production: Unknown.
References: McCrory and O'Haire, 1965.

59. Unnamed Asbestos Occurrence
Location: Sec. 19, T1N, R12E.
Commodity: Asbestos.
Production: Unknown.
References: McCrory and O'Haire, 1965; Stipp et al., 1967.

60. Unnamed Asbestos Occurrence
Location: Sec. 11, T1S, R11E.
Commodity: Asbestos.
Production: Unknown.
References: McCrory and O'Haire, 1965; Stipp et al., 1967.

61. Unnamed Asbestos Occurrence
Location: Sec. 15, T1S, R11E.
Commodity: Asbestos.
Production: Unknown.
References: McCrory and O'Haire, 1965; Stipp et al., 1967.

62. Unnamed Asbestos Occurrence
Location: Sec. 32, T1S, R11E.
Commodity: Asbestos.
Production: Unknown.
References: McCrory and O'Haire, 1965.

63. Unnamed Asbestos Occurrence
Location: Sec. 34, T2N, R14E.
Commodity: Asbestos.
Production: Unknown.
References: McCrory and O'Haire, 1965; Stipp et al., 1967.

64. Unnamed Turquoise Occurrence
Location: Sec. 20, T1N, R14E.

Commodity: Gemstone.
Production: Unknown.
References: McCrory and O'Haire, 1965.

65. **Unnamed Limestone Occurrence**
Location: Sec. 12, T1N, R14E.
Commodity: Limestone.
Production: Unknown.
References: McCrory and O'Haire, 1965.

66. **Unnamed Chrysocolla Occurrence**
Location: Sec. 3, 4, T1S, R14E.
Commodity: Gemstone.
Production: Unknown.
References: McCrory and O'Haire, 1965; Stipp et al., 1967.

67. **Unnamed Granite Occurrence**
Location: Sec. 23, 24, T1S, R14E.
Commodity: Building stone, U.
Production: Unknown.
References: McCrory and O'Haire, 1965; Luning et al., 1982.

68. **Unnamed Perlite Occurrence**
Location: Sec. 15, T1S, R12E.
Commodity: Perlite.
Production: Unknown.
References: McCrory and O'Haire, 1965; Stipp et al., 1967.

69. **Unnamed Limestone Occurrence**
Location: Sec. 36, T1S, R12E.
Commodity: Limestone.
Production: Unknown.
References: McCrory and O'Haire, 1965.

71. **Unnamed Perlite Occurrence**
Location: Sec. 12, 14, 23, 24, T1S, R12E.
Commodity: Perlite.
Production: Unknown.
Reference: McCrory and O'Haire, 1965; Arizona Bureau of Mines, 1969.

72. **Unnamed Rhyolite Occurrence**
Location: Sec. 24, T2S, R11E.
Commodity: Building stone.
Production: Unknown.
Reference: McCrory and O'Haire, 1965.

73. **Gonzales Pass Deposit**
Location: Sec. 16, T2S, R11E.
Commodity: Ba.
Production: Unknown.
Reference: McCrory and O'Haire, 1965; Arizona Bureau of Mines, 1969.

74. **Unnamed Asbestos Occurrence**

Commodity: Gemstone.
Production: Unknown.
References: McCrory and O'Haire, 1965.

65. Unnamed Limestone Occurrence
Location: Sec. 12, T1N, R14E.
Commodity: Limestone.
Production: Unknown.
References: McCrory and O'Haire, 1965.

66. Unnamed Chrysocolla Occurrence
Location: Sec. 3, 4, T1S, R14E.
Commodity: Gemstone.
Production: Unknown.
References: McCrory and O'Haire, 1965; Stipp et al., 1967.

67. Unnamed Granite Occurrence
Location: Sec. 23, 24, T1S, R14E.
Commodity: Building stone, U.
Production: Unknown.
References: McCrory and O'Haire, 1965; Luning et al., 1972.

68. Unnamed Perlite Occurrence
Location: Sec. 15, T1S, R12E.
Commodity: Perlite.
Production: Unknown.
References: McCrory and O'Haire, 1965; Stipp et al., 1967.

69. Unnamed Limestone Occurrence
Location: Sec. 36, T1S, R12E.
Commodity: Limestone.
Production: Unknown.
References: McCrory and O'Haire, 1965.

71. Unnamed Perlite Occurrence
Location: Sec. 12, 14, 23, 24, T1S, R12E.
Commodity: Perlite.
Production: Unknown.
Reference: McCrory and O'Haire, 1965; Arizona Bureau of Mines, 1969.

72. Unnamed Rhyolite Occurrence
Location: Sec. 24, T2S, R11E.
Commodity: Building stone.
Production: Unknown.
Reference: McCrory and O'Haire, 1965.

73. Gonzales Pass Deposit
Location: Sec. 16, T2S, R11E.
Commodity: Ba.
Production: Unknown.
Reference: McCrory and O'Haire, 1965; Arizona Bureau of Mines, 1969.

74. Unnamed Asbestos Occurrence

Location: Sec. 19, 30, T3S, R14E.
Commodity: Asbestos.
Production: Unknown.
Reference: McCrory and O'Haire, 1965; Stipp et al., 1967.

75. **Unnamed Manganese Occurrence**
Location: Sec. 24, T2N, R14E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

76. **Unnamed Manganese Occurrence**
Location: Sec. 35, T2N, R14E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

77. **Unnamed Copper and Uranium Occurrence**
Location: Sec. 25, T2N, R14E.
Commodity: Cu, U.
Production: Unknown.
Reference: Stipp et al., 1967; Luning et al., 1982.

78. **Unnamed Mineral Occurrence**
Location: Sec. 25, T2N, R13E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

79. **Unnamed Tungsten Occurrence**
Location: Sec. 35, T2N, R13E.
Commodity: W.
Production: Unknown.
Reference: Stipp et al., 1967.

80. **Unnamed Tungsten Occurrence**
Location: Sec. 35, T2N, R13E.
Commodity: W.
Production: Unknown.
Reference: Stipp et al., 1967.

81. **Unnamed Silver, Tungsten, Copper and Gold Occurrence**
Location: Sec. 11, T2N, R13E.
Commodity: Ag, W, Cu, Au.
Production: Unknown.
Reference: Stipp et al., 1967.

82. **Unnamed Molybdenum and Tungsten Occurrence**
Location: Sec. 6, T1N, R15E.
Commodity: Mo, W.
Production: Unknown.
Reference: Stipp et al., 1967.

83. **Bluebird Mine**
Location: Sec. 30, T1N, R15E.

Location: Sec. 19, 30, T3S, R14E.
Commodity: Asbestos.
Production: Unknown.
Reference: McCrory and O'Haire, 1965; Stipp et al., 1967.

75. Unnamed Manganese Occurrence
Location: Sec. 24, T2N, R14E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

76. Unnamed Manganese Occurrence
Location: Sec. 36, T2N, R14E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

77. Unnamed Copper and Uranium Occurrence
Location: Sec. 25, T2N, R14E.
Commodity: Cu, U.
Production: Unknown.
Reference: Stipp et al., 1967; Luning et al., 1981.

78. Unnamed Mineral Occurrence
Location: Sec. 35, T2N, R13E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

79. Unnamed Tungsten Occurrence
Location: Sec. 35, T2N, R13E.
Commodity: W.
Production: Unknown.
Reference: Stipp et al., 1967.

80. Unnamed Tungsten Occurrence
Location: Sec. 36, T2N, R13E.
Commodity: W.
Production: Unknown.
Reference: Stipp et al., 1967.

81. Unnamed Silver, Tungsten, Copper and Gold Occurrence
Location: Sec. 13, T2N, R13E.
Commodity: Ag, W, Cu, Au.
Production: Unknown.
Reference: Stipp et al., 1967.

82. Unnamed Molybdenum and Tungsten Occurrence
Location: Sec. 6, T1N, R15E.
Commodity: Mo, W.
Production: Unknown.
Reference: Stipp et al., 1967.

83. Bluebird Mine
Location: Sec. 30, T1N, R15E.

Commodity: Cu, Mo, Ag, Au.
Production: Currently producing.
Reference: Stipp et al., 1967; Arizona Department of Mineral Resources, 1981.

84. **Unnamed Mineral Occurrence**
Location: Sec. 7, T1N, R14E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

85. **Unnamed Uranium Occurrence**
Location: Sec. 8, T1N, R14E.
Commodity: U.
Production: Unknown.
Reference: Stipp et al., 1967; Luning et al., 1982.

86. **Unnamed Lead, Molybdenum, Tungsten, Gold and Zinc Occurrence**
Location: Sec. 21, 22, 27, 28, T1N, R14E.
Commodity: Pb, Mo, W, Au, Zn.
Production: Unknown.
Reference: Stipp et al., 1967.

87. **Unnamed Gem and Ornamental Stone Occurrence**
Location: Sec. 23, 26, T1N, R14E.
Commodity: Gemstone.
Production: Unknown.
Reference: Stipp et al., 1967.

88. **Unnamed Mineral Occurrence**
Location: Sec. 33, T1N, R13E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

89. **Unnamed Mineral Occurrence**
Location: Sec. 23, T1N, R13E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

90. **Unnamed Lead, Silver, Copper, Gold and Zinc Occurrence**
Location: Sec. 26, T1N, R13E.
Commodity: Pb, Ag, Cu, Au, Zn.
Production: Unknown.
Reference: Stipp et al., 1967.

91. **Unnamed Mineral Occurrence**
Location: Sec. 11, T1N, R12E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

92. **Unnamed Mineral Occurrence**
Location: Sec. 15, T1N, R12E.

Commodity: Cu, Mo, Ag, Au.
Production: Currently producing.
Reference: Stipp et al., 1967; Arizona Department of Mineral Resources, 1981.

84. Unnamed Mineral Occurrence
Location: Sec. 7, T1N, R14E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

85. Unnamed Uranium Occurrence
Location: Sec. 8, T1N, R14E.
Commodity: U.
Production: Unknown.
Reference: Stipp et al., 1967; Lunfod et al., 1982.

86. Unnamed Lead, Molybdenum, Tungsten, Gold and Zinc Occurrence
Location: Sec. 21, 22, 27, 28, T1N, R14E.
Commodity: Pb, Mo, W, Au, Zn.
Production: Unknown.
Reference: Stipp et al., 1967.

87. Unnamed Coal and Ornamental Stone Occurrence
Location: Sec. 23, 26, T1N, R14E.
Commodity: Geneltone.
Production: Unknown.
Reference: Stipp et al., 1967.

88. Unnamed Mineral Occurrence
Location: Sec. 23, T1N, R13E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

89. Unnamed Mineral Occurrence
Location: Sec. 23, T1N, R13E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

90. Unnamed Lead, Silver, Copper, Gold and Zinc Occurrence
Location: Sec. 26, T1N, R13E.
Commodity: Pb, Ag, Cu, Au, Zn.
Production: Unknown.
Reference: Stipp et al., 1967.

91. Unnamed Mineral Occurrence
Location: Sec. 11, T1N, R12E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

92. Unnamed Mineral Occurrence
Location: Sec. 15, T1N, R12E.

Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

93. **Unnamed Mineral Occurrence**
Location: Sec. 23, T1N, R12E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

94. **Unnamed Mineral Occurrence**
Location: Sec. 33, 34, T1N, R12E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

95. **Unnamed Mineral Occurrence**
Location: Sec. 35, 36, T1N, R12E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

96. **Unnamed Mercury Occurrence**
Location: Sec. 5, T1S, R10E.
Commodity: Hg.
Production: Unknown.
Reference: Stipp et al., 1967.

97. **Unnamed Silver and Gold Occurrence**
Location: Sec. 5, T1S, R10E.
Commodity: Ag, Au.
Production: Unknown.
Reference: Stipp et al., 1967.

98. **Unnamed Asbestos Occurrence**
Location: Sec. 30, T1S, R11E.
Commodity: Asbestos.
Production: Unknown.
Reference: Stipp et al., 1967.

99. **Unnamed Mineral Occurrence**
Location: Sec. 20, T1S, R11E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

100. **Unnamed Mineral Occurrence**
Location: Sec. 23, T1S, R11E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

101. **Unnamed Mineral Occurrence**
Location: Sec. 27, T1S, R11E.
Commodity: Unknown.

Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

93. Unnamed Mineral Occurrence
Location: Sec. 23, T1N, R12E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

94. Unnamed Mineral Occurrence
Location: Sec. 33, 34, T1N, R12E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

95. Unnamed Mineral Occurrence
Location: Sec. 35, 36, T1N, R12E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

96. Unnamed Mercury Occurrence
Location: Sec. 0, T1S, R12E.
Commodity: Hg.
Production: Unknown.
Reference: Stipp et al., 1967.

97. Unnamed Silver and Gold Occurrence
Location: Sec. 5, T1S, R10E.
Commodity: Ag, Au.
Production: Unknown.
Reference: Stipp et al., 1967.

98. Unnamed Asbestos Occurrence
Location: Sec. 30, T1S, R11E.
Commodity: Asbestos.
Production: Unknown.
Reference: Stipp et al., 1967.

99. Unnamed Mineral Occurrence
Location: Sec. 20, T1S, R11E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

100. Unnamed Mineral Occurrence
Location: Sec. 23, T1S, R10E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

101. Unnamed Mineral Occurrence
Location: Sec. 27, T1S, R11E.
Commodity: Unknown.

Production: Unknown.
Reference: Stipp et al., 1967.

102. **Unnamed Mineral Occurrence**
Location: Sec. 12, 13, T1S, R12E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

103. **Unnamed Manganese Occurrence**
Location: Sec. 26, T1S, R12E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

104. **Unnamed Manganese Occurrence**
Location: Sec. 36, T1S, R12E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

105. **Unnamed Lead, Molybdenum and Copper Occurrence**
Location: Sec. 29, T1S, R12E.
Commodity: Pb, Mo, Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

106. **Unnamed Silver Occurrence**
Location: Sec. 26, T1S, R12E.
Commodity: Ag.
Production: Unknown.
Reference: Stipp et al., 1967.

107. **Unnamed Mineral Occurrence**
Location: Sec. 28, T1S, R13E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

108. **Unnamed Tungsten Occurrence**
Location: Sec. 15, T1S, R13E.
Commodity: W.
Production: Unknown.
Reference: Stipp et al., 1967.

109. **Unnamed Silver and Gold Occurrence**
Location: Sec. 12, T5S, R13E.
Commodity: Ag, Au.
Production: Unknown.
Reference: Stipp et al., 1967.

110. **Unnamed Mineral Occurrence**
Location: Sec. 18, T1S, R14E.
Commodity: Unknown.
Production: Unknown.

Production: Unknown.
Reference: Stipp et al., 1967.

102. Unnamed Mineral Occurrence
Location: Sec. 12, 13, T15, R12E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

103. Unnamed Manganese Occurrence
Location: Sec. 26, T15, R12E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

104. Unnamed Manganese Occurrence
Location: Sec. 36, T15, R12E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

105. Unnamed Lead, Molybdenum and Copper Occurrence
Location: Sec. 25, T15, R12E.
Commodity: Pb, Mo, Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

106. Unnamed Silver Occurrence
Location: Sec. 26, T15, R12E.
Commodity: Ag.
Production: Unknown.
Reference: Stipp et al., 1967.

107. Unnamed Mineral Occurrence
Location: Sec. 26, T15, R12E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

108. Unnamed Tungsten Occurrence
Location: Sec. 15, T15, R12E.
Commodity: W.
Production: Unknown.
Reference: Stipp et al., 1967.

109. Unnamed Silver and Gold Occurrence
Location: Sec. 12, T15, R12E.
Commodity: Ag, Au.
Production: Unknown.
Reference: Stipp et al., 1967.

110. Unnamed Mineral Occurrence
Location: Sec. 18, T15, R14E.
Commodity: Unknown.
Production: Unknown.

Reference: Stipp et al., 1967.

111. **Unnamed Mercury Occurrence**
Location: Sec. 9, 16, T1S, R14E.
Commodity: Hg.
Production: Unknown.
Reference: Stipp et al., 1967.

112. **Unnamed Silver, Copper and Gold Occurrence**
Location: Sec. 9, T1S, R14E.
Commodity: Ag, Cu, Au.
Production: Unknown.
Reference: Stipp et al., 1967.

113. **Unnamed Copper Occurrence**
Location: Sec. 15, T1S, R14E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

114. **Unnamed Copper and Gold Occurrence**
Location: Sec. 29, T1S, R14E.
Commodity: Cu, Au.
Production: Unknown.
Reference: Stipp et al., 1967.

115. **Unnamed Copper Occurrence**
Location: Sec. 33, T1S, R14E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

116. **Unnamed Copper Occurrence**
Location: Sec. 36, T1S, R14E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

117. **Unnamed Copper Occurrence**
Location: Sec. 31, T1S, R15E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

118. **Unnamed Lead, Silver, Tungsten, Copper, Gold, Zinc and Uranium Occurrence**
Location: Sec. 7, T2S, R15E.
Commodity: Pb, Ag, W, Cu, Au, Zn, U.
Production: Unknown.
Reference: Stipp et al., 1967.

119. **Unnamed Lead, Silver, Tungsten, Copper, Gold and Zinc Occurrence**
Location: Sec. 13, T2S, R14E.
Commodity: Pb, Ag, W, Cu, Au, Zn.
Production: Unknown.

Reference: Stipp et al., 1967.

111. Unnamed Mercury Occurrence
Location: Sec. 9, 16, T15, R14E.
Commodity: Hg.
Production: Unknown.
Reference: Stipp et al., 1967.

112. Unnamed Silver, Copper and Gold Occurrence
Location: Sec. 9, T15, R14E.
Commodity: Ag, Cu, Au.
Production: Unknown.
Reference: Stipp et al., 1967.

113. Unnamed Copper Occurrence
Location: Sec. 14, T15, R14E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

114. Unnamed Copper and Gold Occurrence
Location: Sec. 23, T15, R14E.
Commodity: Cu, Au.
Production: Unknown.
Reference: Stipp et al., 1967.

115. Unnamed Copper Occurrence
Location: Sec. 33, T15, R14E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

116. Unnamed Copper Occurrence
Location: Sec. 33, T15, R14E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

117. Unnamed Copper Occurrence
Location: Sec. 11, T15, R13E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

118. Unnamed Lead, Silver, Tungsten, Copper, Gold, Zinc and Uranium Occurrence
Location: Sec. 7, T15, R13E.
Commodity: Pb, Ag, W, Cu, Au, Zn, U.
Production: Unknown.
Reference: Stipp et al., 1967.

119. Unnamed Lead, Silver, Tungsten, Copper, Gold and Zinc Occurrence
Location: Sec. 13, T15, R14E.
Commodity: Pb, Ag, W, Cu, Au, Zn.
Production: Unknown.

Reference: Stipp et al., 1967.

120. **Unnamed Silver, Copper and Gold Occurrence**
Location: Sec. 28, 29, T2S, R14E.
Commodity: Ag, Cu, Au.
Production: Unknown.
Reference: Stipp et al., 1967.

121. **Unnamed Manganese Occurrence**
Location: Sec. 7, 18, T2S, R13E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

122. **Unnamed Silver Occurrence**
Location: Sec. 7, T2S, R13E.
Commodity: Ag.
Reference: Stipp et al., 1967.

123. **Unnamed Manganese Occurrence**
Location: Sec. 3, T2S, R12E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

124. **Unnamed Manganese Occurrence**
Location: Sec. 22, T2S, R12E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

125. **Unnamed Manganese Occurrence**
Location: Sec. 26, T2S, R12E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

126. **Unnamed Mineral Occurrence**
Location: Sec. 24, T2S, R12E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

127. **Unnamed Lead, Copper and Zinc Occurrence**
Location: Sec. 2, T2S, R12E.
Commodity: Pb, Cu, Zn.
Production: Unknown.
Reference: Stipp et al., 1967.

128. **Unnamed Manganese Occurrence**
Location: Sec. 23, T2S, R11E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

Reference: Stipp et al., 1967.

120. Unnamed Silver, Copper and Gold Occurrence
Location: Sec. 28, 29, T25, R14E.
Commodity: Ag, Cu, Au.
Production: Unknown.
Reference: Stipp et al., 1967.

121. Unnamed Manganese Occurrence
Location: Sec. 7, 18, T25, R13E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

122. Unnamed Silver Occurrence
Location: Sec. 7, T25, R12E.
Commodity: Ag.
Reference: Stipp et al., 1967.

123. Unnamed Manganese Occurrence
Location: Sec. 3, T25, R10E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

124. Unnamed Manganese Occurrence
Location: Sec. 22, T25, R12E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

125. Unnamed Manganese Occurrence
Location: Sec. 20, T25, R12E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

126. Unnamed Mineral Occurrence
Location: Sec. 24, T25, R12E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

127. Unnamed Lead, Copper and Zinc Occurrence
Location: Sec. 2, T25, R12E.
Commodity: Pb, Cu, Zn.
Production: Unknown.
Reference: Stipp et al., 1967.

128. Unnamed Manganese Occurrence
Location: Sec. 23, T25, R11E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

129. **Unnamed Silver Occurrence**
Location: Sec. 26, T2S, R11E.
Commodity: Ag.
Production: Unknown.
Reference: Stipp et al., 1967.

130. **Unnamed Silver Occurrence**
Location: Sec. 34, T2S, R11E.
Commodity: Ag.
Production: Unknown.
Reference: Stipp et al., 1967.

131. **Unnamed Silver, Copper and Gold Occurrence**
Location: Sec. 10, T3S, R11E.
Commodity: Ag, Cu, Au.
Production: Unknown.
Reference: Stipp et al., 1967.

132. **Unnamed Lead, Silver, Copper, Gold and Zinc Occurrence**
Location: Sec. 16, T3S, R11E.
Commodity: Pb, Ag, Cu, Au, Zn.
Production: Unknown.
Reference: Stipp et al., 1967.

134. **Unnamed Mineral Occurrence**
Location: Sec. 20, 29, T3S, R11E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

135. **Unnamed Lead, Silver, Copper, Gold and Zinc Occurrence**
Location: Sec. 18, T3S, R12E.
Commodity: Pb, Ag, Cu, Au, Zn.
Production: Unknown.
Reference: Stipp et al., 1967.

136. **Unnamed Silver Occurrence.**
Location: Sec. 5, T3S, R12E.
Commodity: Ag.
Production: Unknown.
Reference: Stipp et al., 1967.

137. **Unnamed Lead Occurrence**
Location: Sec. 2, T3S, R12E.
Commodity: Pb.
Production: Unknown.
Reference: Stipp et al., 1967.

138. **Unnamed Manganese Occurrence**
Location: Sec. 33, T3S, R12E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

139. **Unnamed Copper Occurrence**

129. Unnamed Silver Occurrence
Location: Sec. 26, T23S, R11E.
Commodity: Ag.
Production: Unknown.
Reference: Stipp et al., 1967.

130. Unnamed Silver Occurrence
Location: Sec. 34, T25S, R11E.
Commodity: Ag.
Production: Unknown.
Reference: Stipp et al., 1967.

131. Unnamed Silver, Copper and Gold Occurrence
Location: Sec. 10, T25S, R11E.
Commodity: Ag, Cu, Au.
Production: Unknown.
Reference: Stipp et al., 1967.

132. Unnamed Lead, Silver, Copper, Gold and Zinc Occurrence
Location: Sec. 15, T25S, R11E.
Commodity: Pb, Ag, Cu, Au, Zn.
Production: Unknown.
Reference: Stipp et al., 1967.

134. Unnamed Mineral Occurrence
Location: Sec. 20, 29, T25S, R11E.
Commodity: Unknown.
Production: Unknown.
Reference: Stipp et al., 1967.

135. Unnamed Lead, Silver, Copper, Gold and Zinc Occurrence
Location: Sec. 16, T25S, R12E.
Commodity: Pb, Ag, Cu, Au, Zn.
Production: Unknown.
Reference: Stipp et al., 1967.

136. Unnamed Silver Occurrence.
Location: Sec. 5, T26S, R12E.
Commodity: Ag.
Production: Unknown.
Reference: Stipp et al., 1967.

137. Unnamed Lead Occurrence
Location: Sec. 2, T25S, R12E.
Commodity: Pb.
Production: Unknown.
Reference: Stipp et al., 1967.

138. Unnamed Manganese Occurrence
Location: Sec. 33, T25S, R12E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

139. Unnamed Copper Occurrence

Location: Sec. 1, T3S, R13E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

140. **Unnamed Copper Occurrence**
Location: Sec. 13, T3S, R13E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

141. **Unnamed Copper Occurrence**
Location: Sec. 18, T3S, R13E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

142. **Unnamed Lead and Copper Occurrence**
Location: Sec. 3, T3S, R13E.
Commodity: Pb, Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

144. **Unnamed Silver and Copper Occurrence**
Location: Sec. 30, T3S, R13E.
Commodity: Ag, Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

145. **Unnamed Lead Occurrence**
Location: Sec. 13, T3S, R13E.
Commodity: Pb.
Production: Unknown.
Reference: Stipp et al., 1967.

146. **Unnamed Copper Occurrence**
Location: Sec. 6, T3S, R14E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

147. **Unnamed Copper Occurrence**
Location: Sec. 36, T3S, R14E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

148. **Unnamed Silver and Copper Occurrence**
Location: Sec. 22, T3S, R14E.
Commodity: Ag, Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

149. **Unnamed Silver and Copper Occurrence**
Location: Sec. 28, 33, T3S, R14E.
Commodity: Ag, Cu.

Location: Sec. 1, T3S, R13E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

140. Unnamed Copper Occurrence
Location: Sec. 14, T3S, R13E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

141. Unnamed Copper Occurrence
Location: Sec. 18, T3S, R13E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

142. Unnamed Lead and Copper Occurrence
Location: Sec. 3, T3S, R13E.
Commodity: Pb, Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

144. Unnamed Silver and Copper Occurrence
Location: Sec. 30, T3S, R13E.
Commodity: Ag, Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

145. Unnamed Lead Occurrence
Location: Sec. 13, T3S, R13E.
Commodity: Pb.
Production: Unknown.
Reference: Stipp et al., 1967.

146. Unnamed Copper Occurrence
Location: Sec. 8, T3S, R14E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

147. Unnamed Copper Occurrence
Location: Sec. 36, T3S, R14E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

148. Unnamed Silver and Copper Occurrence
Location: Sec. 23, T3S, R14E.
Commodity: Ag, Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

149. Unnamed Silver and Copper Occurrence
Location: Sec. 28, 33, T3S, R14E.
Commodity: Ag, Cu.

Production: Unknown.
Reference: Stipp et al., 1967.

150. **Unnamed Silver, Copper and Gold Occurrence**
Location: Sec. 23, T3S, R14E.
Commodity: Ag, Cu, Au.
Production: Unknown.
Reference: Stipp et al., 1967.

151. **Unnamed Lead, Molybdenum, Silver, Copper and Gold Occurrence**
Location: Sec. 27, T3S, R14E.
Commodity: Pb, Mo, Ag, Cu, Au.
Production: Unknown.
Reference: Stipp et al., 1967.

152. **Unnamed Manganese Occurrence**
Location: Sec. 12, T4S, R14E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

153. **Unnamed Manganese Occurrence**
Location: Sec. 18, T4S, R14E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

154. **Unnamed Copper Occurrence**
Location: Sec. 3, T4S, R14E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

155. **Unnamed Lead, Silver and Copper Occurrence**
Location: Sec. 7, T4S, R14E.
Commodity: Pb, Ag, Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

156. **Unnamed Copper Occurrence**
Location: Sec. 20, T4S, R13E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

157. **Unnamed Copper Occurrence**
Location: Sec. 30, T4S, R13E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

158. **Unnamed Silver, Copper and Zinc Occurrence**
Location: Sec. 2, T4S, R13E.
Commodity: Ag, Cu, Zn.
Production: Unknown.

Production: Unknown.
Reference: Stipp et al., 1967.

150. Unnamed Silver, Copper and Gold Occurrence
Location: Sec. 23, T3S, R14E.
Commodity: Ag, Cu, Au.
Production: Unknown.
Reference: Stipp et al., 1967.

151. Unnamed Lead, molybdenum, Silver, Copper and Gold Occurrence
Location: Sec. 27, T3S, R14E.
Commodity: Pb, Mo, Ag, Cu, Au.
Production: Unknown.
Reference: Stipp et al., 1967.

152. Unnamed Manganese Occurrence
Location: Sec. 12, T4S, R14E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

153. Unnamed Manganese Occurrence
Location: Sec. 15, T4S, R14E.
Commodity: Mn.
Production: Unknown.
Reference: Stipp et al., 1967.

154. Unnamed Copper Occurrence
Location: Sec. 3, T4S, R14E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

155. Unnamed Lead, Silver and Copper Occurrence
Location: Sec. 7, T4S, R14E.
Commodity: Pb, Ag, Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

156. Unnamed Copper Occurrence
Location: Sec. 20, T4S, R13E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

157. Unnamed Copper Occurrence
Location: Sec. 30, T4S, R13E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

158. Unnamed Silver, Cadmer and Zinc Occurrence
Location: Sec. 5, T4S, R13E.
Commodity: Ag, Cd, Zn.
Production: Unknown.

Reference: Stipp et al., 1967.

159. **Unnamed Molybdenum and Copper Occurrence**
Location: Sec. 8, T4S, R13E.
Commodity: Mo, Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

160. **Unnamed Molybdenum Occurrence**
Location: Sec. 28, T4S, R13E.
Commodity: Mo.
Production: Unknown.
Reference: Stipp et al., 1967.

161. **Unnamed Copper Occurrence**
Location: Sec. 17, T4S, R11E.
Commodity: Cu, U.
Production: Unknown.
Reference: Stipp et al., 1967; Luning et al., 1982.

162. **Unnamed Uranium Occurrence**
Location: Sec. 7, T5S, R13E.
Commodity: U.
Production: Unknown.
Reference: Stipp et al., 1967.

163. **Unnamed Copper Occurrence**
Location: Sec. 10, T5S, R13E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

164. **Unnamed Bentonite Occurrence**
Location: Sec. 15, T1N, R11E.
Commodity: Bentonite.
Production: Unknown.
Reference: Arizona Bureau of Mines, 1969.

165. **Unnamed Bentonite Occurrence**
Location: Sec. 33, T1S, R13E.
Commodity: Bentonite.
Production: None.
Reference: Arizona Bureau of Mines, 1969.

172. **Unnamed Uranium Occurrence**
Location: Sec. 26, 35, T4S, R11E.
Commodity: U.
Deposit Description:
Stringers and veinlets.
Geology: Associated with copper oxides and carbonates in granite.
Production: None.
Reference: Peirce et al., 1970; Luning et al., 1982.

173. **Hillside Group**

Reference: Stipp et al., 1967.

159. Unnamed Molybdenum and Copper Occurrence
Location: Sec. 8, T4S, R13E.
Commodity: Mo, Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

160. Unnamed Molybdenum Occurrence
Location: Sec. 28, T4S, R13E.
Commodity: Mo.
Production: Unknown.
Reference: Stipp et al., 1967.

161. Unnamed Copper Occurrence
Location: Sec. 17, T4S, R11E.
Commodity: Cu, U.
Production: Unknown.
Reference: Stipp et al., 1967; Luning et al., 1982.

162. Unnamed Uranium Occurrence
Location: Sec. 7, T5S, R13E.
Commodity: U.
Production: Unknown.
Reference: Stipp et al., 1967.

163. Unnamed Copper Occurrence
Location: Sec. 10, T5S, R13E.
Commodity: Cu.
Production: Unknown.
Reference: Stipp et al., 1967.

164. Unnamed Bentonite Occurrence
Location: Sec. 18, T1N, R11E.
Commodity: Bentonite.
Production: Unknown.
Reference: Arizona Bureau of Mines, 1961.

165. Unnamed Bentonite Occurrence
Location: Sec. 33, T1S, R13E.
Commodity: Bentonite.
Production: None.
Reference: Arizona Bureau of Mines, 1961.

172. Unnamed Uranium Occurrence
Location: Sec. 26, 35, T4S, R11E.
Commodity: U.
Deposit Description:
Stringers and veinlets.
Geology: Associated with copper oxides and carbonates in granite.
Production: None.
Reference: Patrice et al., 1970; Luning et al., 1982.

173. Mistake Group

Location: Sec. 35, T4S, R12E.
Commodity: U.
Ore Materials: Torbernite (?).
Deposit Description:
Associated with faulted dike.
Geology: Mineralization associated with copper carbonate in faulted dike in granite.
Production: None.
Reference: Peirce et al., 1970; Luning et al., 1982.

174. **Unnamed Thermal Well**
Location: Sec. 33, T1S, R12E.
Temperature: 53°C.
Well Depth: 1408 meters.
Reference: Witcher et al., 1982.

175. **Unnamed Thermal Well**
Location: Sec. 34, T1S, R12E.
Temperature: 72°C
Well Depth: 1808 meters.
Reference: Witcher et al., 1982.

176. **Unnamed Thermal Well**
Location: Sec. 9, T4S, R13E.
Temperature: 39°C.
Well Depth: 590 meters.
Heat Flow: 95mW/m^2.
Reference: Witcher et al., 1982.

177. **Buckeye Mine**
Location: SE 1/4 Sec. 26, W central Sec. 25, T3S, R12E.
Commodity: Cu.
Deposit Description/Geology:
Mineralization in Tertiary Whitetail Conglomerate, from eroded cappings of Pinal Schist.
Production: Unknown.
Reference: Kennecott, written communication, 1982.

179. **Florence Mine**
Location: SE 1/4 Sec. 12, T5S, R13E.
Commodities: Ag, Pb.
Ore Materials: Silver bearing galena.
Deposit Description:
Vein and disseminated minerals.
Geology: Mineralization in Paleozoic carbonate rocks.
Production: Unknown.
Reference: Cornwall and Krieger, 1975.

180: **Old Ripsey Mine**
Location: SW 1/4 Sec. 12, T5S, R13E.
Commodity: Cu.
Ore Materials: Copper sulfides.
Deposit Description:
Veinlets and disseminations.
Geology: Mineralization in diabase and Precambrian Ruin

Location: Sec. 35, T4S, R12E.
Commodity: U.
Ore Materials: Torbernite (?).
Deposit Description:
Associated with faulted dike.
Geology: Mineralization associated with copper carbonate in faulted dike in granite.
Production: None.
Reference: Peirce et al., 1970; Luning et al., 1982.

170. Unnamed Thermal Well
Location: Sec. 33, T1S, R12E.
Temperature: 53°C.
Well Depth: 1400 meters.
Reference: Witcher et al., 1982.

171. Unnamed Thermal Well
Location: Sec. 34, T1S, R12E.
Temperature: 72°C.
Well Depth: 1800 meters.
Reference: Witcher et al., 1982.

172. Unnamed Thermal Well
Location: Sec. 9, T4S, R12E.
Temperature: 22°C.
Well Depth: 570 meters.
Heat Flow: 95mW/m².
Reference: Witcher et al., 1982.

173. Buckeye Mine
Location: SE 1/4 Sec. 26, W central Sec. 25, T3S, R12E.
Commodity: Cu.
Deposit Description/Geology:
Mineralization in Tertiary Whitewall Conglomerate.
Free native copperings of Final Schist.
Production: Unknown.
Reference: Lawscott, written communication, 1982.

174. Florence Mine
Location: SE 1/4 Sec. 12, T6S, R12E.
Commodities: Ag, Pb.
Ore Materials: Silver bearing galena.
Deposit Description:
Vein and disseminated minerals.
Geology: Mineralization in Paleozoic carbonate rocks.
Production: Unknown.
Reference: Cornwall and Krieger, 1975.

175. Old Ripsey Mine
Location: SW 1/4 Sec. 12, T6S, R12E.
Commodity: Cu.
Ore Materials: Copper sulfides.
Deposit Description:
Veinlets and disseminations.
Geology: Mineralization in diabase and Precambrian Buth

Granite.
Production: Unknown.
Reference: Cornwall and Krieger, 1975.

181. **King #1, 2, 3**
Location: Sec. 7, T1S, R14E.
Commodity: Cu (potential), U (occurrence).
Ore Materials: Chrysocolla, metatorbernite, some malachite.
Deposit Description:
Vein deposit.
Geology: In Tertiary granite.
Production: None.
Reference: Luning et al., 1982.

182. **Unnamed Uranium Occurrence**
Location: Sec. 20, T2N, R12E (location approximate).
Commodity: U.
Production: Unknown.
Reference: Luning et al., 1982.

183. **Unnamed Uranium Occurrence**
Location: Sec. 29, T1N, R14E (location approximate).
Commodity: U.
Production: Unknown.
Reference: Luning et al., 1982.

184. **Unnamed Uranium Occurrence**
Location: Sec. 18, T1S, R12E (location approximate).
Commodity: U.
Production: Unknown.
Reference: Luning et al., 1982.

185. **Unnamed Uranium Occurrence**
Location: Sec. 8, T1S, R14E (location approximate).
Commodity: U.
Production: Unknown.
Reference: Luning et al., 1982.

186. **Unnamed Uranium Occurrence**
Location: Sec. 14, T1S, R14E (location approximate).
Commodity: U.
Production: Unknown.
Reference: Luning et al., 1982.

187. **Unnamed Uranium Occurrence**
Location: Sec. 30, T1S, R14E (location approximate).
Commodity: U.
Production: Unknown.
Reference: Luning et al., 1982.

Mining Claims, Leases, and Material Sites

There are numerous mining claims within the Sonora GRA. According to

Granite.
Production: Unknown.
Reference: Cornwall and Krieger, 1975.

181. King #1, 2, 3
Location: Sec. 7, T15, R14E.
Commodity: Cu (potential), U (occurrence).
Ore Materials: Chrysocolla, metatorbernite, some malachite.
Deposit Description:
Vein deposit.
Geology: In Tertiary granite.
Production: None.
Reference: Lanting et al., 1982.

182. Unnamed Uranium Occurrence
Location: Sec. 20, T2N, R12E (location approximate).
Commodity: U.
Production: Unknown.
Reference: Lanting et al., 1982.

183. Unnamed Uranium Occurrence
Location: Sec. 29, T1N, R14E (location approximate).
Commodity: U.
Production: Unknown.
Reference: Lanting et al., 1982.

184. Unnamed Uranium Occurrence
Location: Sec. 16, T1S, R12E (location approximate).
Commodity: U.
Production: Unknown.
Reference: Lanting et al., 1982.

185. Unnamed Uranium Occurrence
Location: Sec. 8, T1S, R14E (location approximate).
Commodity: U.
Production: Unknown.
Reference: Lanting et al., 1982.

186. Unnamed Uranium Occurrence
Location: Sec. 14, T1S, R14E (location approximate).
Commodity: U.
Production: Unknown.
Reference: Lanting et al., 1982.

187. Unnamed Uranium Occurrence
Location: Sec. 30, T1S, R14E (location approximate).
Commodity: U.
Production: Unknown.
Reference: Lanting et al., 1982.

Mining Claims, Leases, and Material Sites

There are numerous mining claims within the Sonora GRA. According to

the BLM records (as of June, 1982), in the White Canyon WSA and adjacent area, the highest density of claims is in the southern end of the WSA. Patented claims are held in land adjacent to the WSA on the east and west sides. The claim density, i.e., the number of claims per square mile (section), is shown in figure 5 and more detailed records are included in table 1.

In spite of our efforts, we were unable to determine the specific types of deposits or mineral commodities for which these claims were filed.

Within the Sonora GRA there are few material sites. These are scattered across the GRA.

Mineral Deposit Types

Geological environments to be considered as potentially favorable for the occurrence of mineral or energy resources include the following:

Older Precambrian igneous and metamorphic rocks,

Younger Precambrian sedimentary rocks,

Paleozoic sediments,

Laramide intrusive rocks,

Mid-Tertiary volcanic rocks,

Mid-Tertiary basin-fill sediments,

Late Tertiary basin-fill sediments,

Recent alluvium, and

Active geothermal systems.

Geologic environments and associated mineral deposit types are shown in table 2.

Older Precambrian Rocks

Numerous massive sulfide deposits are found in the Precambrian rocks in Arizona. Invariably, the deposits are associated with submarine rhyolitic

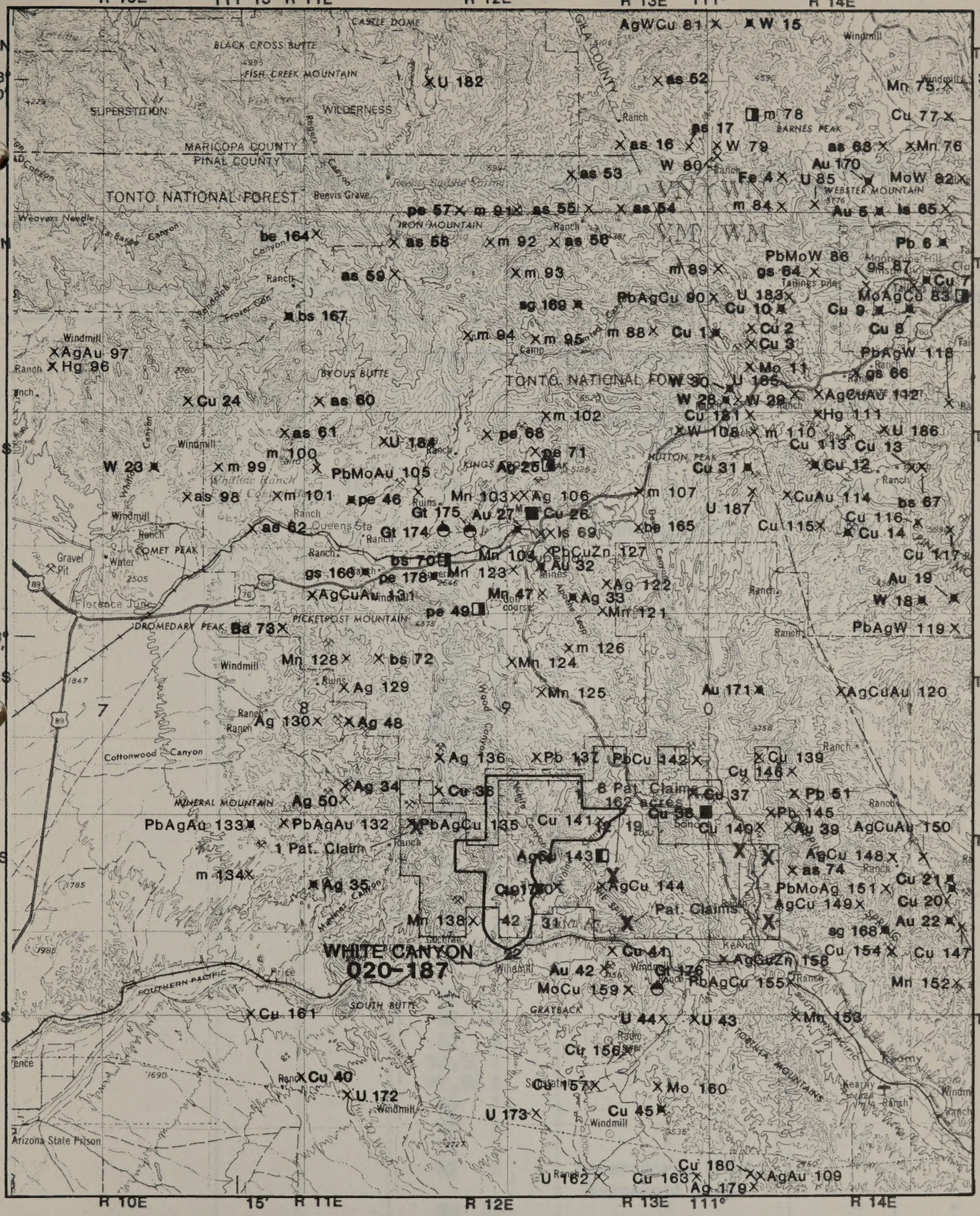

Figure 5 **CLAIM DENSITY MAP, WITH OIL AND GAS LEASING STATUS, OF THE SONORA AREA, ARIZONA.**

Note: hachured lines oil and gas leases; numbers are claims per section.

TABLE 1

CLAIM DENSITY RECORDS IN THE WILDERNESS STUDY AREAS (WSA), SONORA GRA
ACCORDING TO BLM (JUNE 1982), ARIZONA STATE OFFICE

Township	Range	Section	Claims For Each Section	Claimants	Latest Assmt. Date	Remarks
			WSA 020-187 White Canyon			
3S	12E	1	SE 1	Wahl, Curtis/ Lindauer, Louise/ Tanner Co.	1981	placer
		12	NE 1	"	none	"
		23	E2 1	Kennecott Corp.	1981	lode
			S2 1	"	"	"
			SW 2	"	"	"
			SE 7	"	"	"
		26	N2 3	"	"	"
			S2 4	"	"	"
			W2 2	"	"	"
			E2 2	"	"	"
			NE,S2 1	"	"	"
			N2,SW 1	"	"	"
			NW 7	"	"	"
			SW 10	"	"	"
			NE 10	"	"	"
			SE 10	"	"	"
		27	E2 2	"	"	"
			S2 2	"	"	"
			SW 1	"	"	"
			NE 2	"	"	"
			SE 12	"	"	"
		34	E2 2	"	"	"
			W2 3	"	"	"
			S2 3	"	"	"
			N2,SE 1	"	"	"
			N2,SW 1	"	"	"
			SW 7	"	"	"
			NE 9	"	"	"
			SE 1	"	"	"
			N2 5	Beversdorf, Frank/ Kennecott Corp.	"	"
			NW 10	"	"	"

TABLE (Cont'd.)

Township	Range	Section	Claims For Each Section	Claimants	Latest Assmt. Date	Remarks
			WSA 020-187 White Canyon (Cont'd.)			
3S	12E	35	SW 1	Beversdorf, Frank	1981	lode
			NW 11	Beversdorf, Frank/ Kennecott Corp.	"	"
			All 1	Kennecott Corp.	"	"
			N2 5	"	"	"
			W2 2	"	"	"
			E2 1	"	"	"
			NE 10	"	"	"
4S	12E	3	All 1	"	"	"
			N2 1	"	"	"
			W2 4	"	"	"
			E2 4	"	"	"
			NW 8	"	"	"
			NE 4	"	"	"
3S	13E	17	All 1	"	"	"
			W2 1	"	"	"
			N2 4	"	"	"
			NW 13	Kennecott Corp./ Hing, Ally O.	"	"
		18	SW 1	Kennecott Corp.	none	"
			SE 6	"	1981	"
			NE 5	Hing, Ally O.	none	"

TABLE (Cont'd.)

Township	Range	Section	Claims Per Each Section	Claimants	Latest Assmt. Data	Remarks
				WSA 080-187 White Canyon (Cont'd.)		
4S	12E	3S	SW 1	Beaverdorf, Frank	1981	Lode
			NW 11	Beaverdorf, Frank/ Kennecott Corp.	"	
			A11 1	Kennecott Corp.	"	"
			NE 3	"	"	"
			NW 3	"	"	"
			SE 1	"	"	"
			NE 10	"	"	"
4S	12E	5	A11 1	"	"	"
			NE 1	"	"	"
			NW 4	"	"	"
			SW 4	"	"	"
			SE 1	"	"	"
			NW 8	"	"	"
			NE 1	"	"	"
3S	13E	17	A11 1	"	"	"
			NE 1	"	"	"
			NW 1	"	"	"
			SW 10	Kennecott Corp./ Utah, Alty G.		"
		18	SW 1	Kennecott Corp.	None	
			SE 8	"	1983	"
			NE 5	Utah, Alty G.	None	

Table 2. GEOLOGICAL ENVIROMENTS OF THE SONORA AREA AND ASSOCIATED POTENTIAL MINERAL DEPOSIT TYPES

MINERAL DEPOSIT TYPE / GEOLOGICAL ENVIROMENT - HOST ROCKS	Porphyry-Type Deposits	Hydrothermal Deposits (including replacement deposits)	Contact Metamorphic Deposits	Stratiform Deposits	Sedimentary Deposits (conglomerate)	Uranium Deposits (all types)	Hydrocarbon Deposits	Low Temperature Geothermal Deposits	Placer Deposits
Active Geothermal Systems								X	
Tertiary and Quaternary Alluvium									X
Late Tertiary Basin-Fill Sediments								X	
Mid-Tertiary Volcanic Deposits		X				X			
Mid-Tertiary Basin-Fill Sediments					X	X			
Laramide Intrusive Rocks	X	X							
Paleozoic Sediments				X			X		
Younger Precambrian Sedimentary Rocks			X			X			
Older Precambrian Igneous and Metamorphic Rocks		X				X			

Table 2. GEOLOGICAL ENVIRONMENTS OF THE KONDORA AREA AND ASSOCIATED POTENTIAL MINERAL DEPOSIT TYPES

GEOLOGICAL ENVIRONMENTS – HOST ROCKS / MINERAL DEPOSIT TYPES	Cretaceous-Tertiary Volcanics	Triassic-Jurassic Intrusives (Kondora Pluton)	Paleozoic Metamorphic Rocks	Paleozoic Sedimentary Rocks	Paleozoic Volcanics (Devonian)	Mesozoic Volcanics (Jurassic)	Mesozoic Sedimentary Rocks	Mesozoic Intrusives (Cretaceous-Tertiary)	Active Geothermal Systems
Active Geothermal Systems									X
Industry and Quaternary Activity									X
Late Tertiary Basin-Fill Sediments									X
Mid-Tertiary Volcanic Deposits		X						X	
Mid-Tertiary Basin-Fill Sediments					X	X			
Juvenile Intrusive Rocks	X	X							
Paleozoic Sediments				X			X		
Younger Precambrian Sedimentary Rocks			X						
Older Precambrian Igneous and Metamorphic Rocks		X							

volcanism (Donelly and Hahn, 1981) and are either of the proximal or distal type (Anderson and Guilbert, 1979). The proximal deposits are copper- and, locally, zinc-rich rock and were formed atop or on the flanks of rhyolitic centers; the distal types are zinc- and lead-rich, contain silver and gold, and were formed at the same time but in an adjacent basin. The massive sulfide deposits are associated with banded iron formation which are zoned with sulfide facies near the rhyolitic center and carbonate and hematite facies more distant (Anderson and Guilbert, 1979). Metavolcanic rocks occur in the Yavapai Series and in the gneissic terrains to the northwest; both lie to the northwest of the Holbrook Line (see fig. 2A) which separates them from the non-volcanogenic Pinal Schists. The Holbrook Line passes to the north of the GRA which suggests that massive sulfide deposits are not likely to be present in the Precambrian metamorphic rocks of the GRA. This is supported by the fact that there are no identified massive sulfide deposits of the proximal or distal types or banded iron formations in the GRA.

Uranium anomalies are found in the Precambrian granites in the northeast, north, and south-central areas of the GRA (U 43, U 44, bs 67, PbAgW 118, Cu 161, U 162, U 172, U 173, U 184), but concentrations have not been sufficient for production. Precambrian granite containing anomalous uranium values crops out south of the WSA and extends into the southern end of the WSA. No uranium occurrences have been reported within the WSA.

The older Precambrian rocks within the GRA host numerous copper, silver and polymetallic deposits. The Pinal Schist is particularly important where intruded by Laramide age rocks; numerous disseminated and vein type deposits occur at or near contacts. The Pinal Schist and the Precambrian granitic rocks often shows evidence of late stage fluid interaction with the Laramide intrusives (Titley, 1982). Mineralization in these older Precambrian rocks is predominantly related to Laramide intrusive events.

volcanics (Donnelly and Rohn, 1981) and are either of the porphyry or distal type (Lowenstein and Guilbert, 1970). The porphyry deposits are copper and, locally, zinc-rich rock and were formed atop or on the flanks of rhyolitic centers; the distal types are zinc- and lead-rich, contain silver and gold, and were formed at the same time but in an adjacent basin. The massive sulfide deposits are associated with banded iron formation which are zoned with sulfide facies near the rhyolitic center and carbonate and nonsulfide facies more distant (Anderson and Guilbert, 1979). Metavolcanic rocks occur in the Yavapai Series and in the granitic terranes to the northwest; both lie to the northwest of the Holbrook Line (see fig. 3) which separates them from the non-volcanogenic Pinal Schists. The Holbrook Line passes so the north of the USA which suggests that massive sulfide deposits are not likely to be present in the Precambrian metamorphic rocks of the USA. This is supported by the fact that there are no identified massive sulfide deposits of the porphyry or distal types or banded iron formations in the USA.

Uranium occurrences are found in the Precambrian granites in the northeast, north, and south-central areas of the USA (U 63, U 64, Ns 57, Pb&Ug 118, Co 126, U 165, U 172, U 173, U 174). Our conversations have not been sufficient for production. Precambrian granite containing anomalous uranium values crops out south of the USA and extends into the southwest and of the USA. No uranium occurrences have been reported within the USA.

The older Precambrian rocks within the USA host numerous copper, silver and polymetallic deposits. The Pinal Schist is particularly prospective where intruded by Laramide age rocks; numerous disseminated and vein type deposits occur at or near contacts. The Pinal Schist and the Precambrian granitic rocks often show evidence of late stage fluid interaction with the Laramide intrusives (Titley, 1982). Mineralization in these older Precambrian rocks is predominantly related to Laramide intrusive events.

Younger Precambrian Rocks

Deposits within the younger Precambrian rocks in the GRA are predominantly related to Laramide intrusions. These polymetallic deposits are most commonly hosted by limestone units; diabase is also a host rock for these Laramide related deposits (deposits Cu 2, Cu 26 and Ag 33). Limestone contact metamorphosed by Precambrian diabase has yielded asbestos deposits. The Mescal Limestone (site Fe 4) also contains magnetite replacement ore bodies related to Precambrian diabase intrusion.

The Dripping Spring Quartzite contains uranium deposits near diabase intrusions (Granger and Raup, 1969). The deposits lie in a gray carbonaceous siltstone either below or above a barren quartzite and contains uraninite, pyrite, pyrrhotite, base metal sulfides, flourite, ankerite, calcite, phlogopite and chlorite. The above mentioned authors consider the deposits to be genetically related to the diabase because:

1. Late stage differentiates of the diabase are enriched in uranium.
2. Uranium occurs close to diabase.
3. Diabase and uranium mineralization have the same radiometric age.
4. Uranium was deposited at temperatures of several hundred degrees Celsius.

The Dripping Spring Quartzite is part of the Apache Group, and the Apache Group and diabase intrusions occur in both the northeastern and southeastern sections of the GRA, and in the area north of the White Canyon WSA. No uranium occurrences are known to be present in this setting, but the geologic environment, according to the criteria of Granger and Raup (1969), is favorable.

Paleozoic Sediments

Paleozoic sedimentary rocks in southern Arizona have been considered

Younger Precambrian Rocks

Deposits within the younger Precambrian rocks in the SRA are predominantly related to Laramide intrusions. These polymetallic deposits are most commonly hosted by limestone units; Globe is also a host rock for these Laramide related deposits (deposits Cu 2, Cu 26 and Ag 35). Limestone contact metamorphosed by Precambrian diabase has yielded asbestos deposits. The Mescal Limestone (site Fe 4) also contains magnetite replacement bodies related to Precambrian diabase intrusion.

The Bridging Spring Quartzite contains uranium deposits near diabase intrusions (Granger and Raup, 1969). The deposits lie in a gray carbonaceous siltstone either below or above a Bridging quartzite and contains uraninite, pyrite, pyrrhotite, base metal sulfides, fluorite, chlorite, calcite, dolomite and chlorite. The above mentioned authors consider the deposits to be genetically related to the diabase because:

1. Late stage differentiates of the diabase are enriched in uranium.
2. Uranium occurs close to diabase.
3. Diabase and uranium mineralization have the same radiometric age.
4. Uranium was deposited at temperatures of several hundred degrees Celsius.

The Bridging Spring Quartzite is part of the Apache Group, and the Apache Group and diabase intrusions occur in both the northeastern and southeastern sections of the SRA, and in the area north of the Globe Lavaca WSA. No uranium occurrences are known to be present in this setting, but could exist. According to the criteria of Granger and Raup (1969), is favorable.

Paleozoic Sediments

Paleozoic sedimentary rocks in southern Arizona have been considered

potentially favorable for accumulation of hydrocarbons, especially those sediments located in the Overthrust Belt (Peirce, 1982; Keith, 1980). All exploration holes drilled in the area to date, however, have been dry (Peirce, 1979; Keith, 1981; Peirce, 1982; see fig. 6). In the Sonora GRA two dry wells have been drilled in the southern part of the GRA (see fig. 6). The Paleozoic rocks are structurally complex and intruded by several Laramide and more recent intrusives and are not considered favorable for accumulation of hydrocarbons.

The Martin Formation, east of the GRA, contains an iron formation in the upper part of the section. Hematite occurs as ooliths with chamosite in a matrix of calcite, dolomite, and quartz silt. In places, this bed is five to seven feet thick (Willden, 1960). Iron rich layers on a much smaller scale have been reported within the GRA (Banks and Krieger, 1977).

Laramide Intrusive Rocks

The Laramide was a time of emplacement of all but one (Bisbee) of the porphyry copper deposits in Arizona and adjacent New Mexico and Mexico. Of the 35 major porphyry copper deposits in this region, 32 lie to the southeast of the Holbrook Line where basement is Pinal Schist, and 3 lie to the northwest where basement consists of Yavapai Series and gneissic-metavolcanic terrain (see. fig. 2). The intrusives associated with the porphyry copper deposits were emplaced during the westward sweep of the magmatic arc (Damon et al., 1981; Clark et al., 1982) and possibly are related to the decrease in the dip of the Benioff zone at this time (Coney and Reynolds, 1977). The porphyry copper deposits appear to be aligned along northwest and east-northeast trends (see fig. 2; Heidrick and Titley, 1982). The northwesterly trend is sub-parallel to Mesozoic linear discontinuities in depositional patterns (Titley, 1976); the trend of Laramide basement-cored

potentially favorable for accumulation of hydrocarbons, especially those anticlines located in the Southwest Belt (Peirce, 1982; Keith, 1980). All exploration holes drilled in the area to date, however, have been dry (Peirce, 1979; Keith, 1981; Peirce, 1982; see fig. 6). In the Sonora Quad two dry wells have been drilled in the southern part of the SRA (see fig. 6). The Paleozoic rocks are structurally complex and intruded by several Laramide and more recent intrusives and are not considered favorable for accumulation of hydrocarbons.

The Martin Formation, most of the Abo, contains no iron formation in the upper part of the section. Hematite occurs as mottling with chamosite in a matrix of calcite, dolomite, and quartz silt. In places, this bed is five to seven feet thick (Keith, 1981). Iron rich layers on a much smaller scale have been reported within the Abo (Hanna and Kinney, 1977).

Laramide Intrusive Rocks

The Laramide was a time of replacement of all but one (Bisbee) of the porphyry copper deposits in Arizona and adjacent New Mexico and Mexico. Of the 35 major porphyry copper deposits in this region, 22 lie to the southeast of the Mogollon Line where basement is Pinal Schist, and 3 lie to the northwest where basement consists of Yavapai Series and Granite-Rhyolite terrain (see fig. 2). The intrusives associated with the porphyry copper deposits were emplaced during the westward sweep of the magmatic arc (Damon et al., 1981; Clark et al., 1982) and possibly are related to the overlying in the dip of the Benioff zone at this time (Coney and Reynolds, 1977). The porphyry copper deposits appear to be aligned along northwest and east-northeast trends (see fig. 2; Mogollon Rim Trilby, 1983). The northwesterly trend is sub-parallel to Mesozoic linear discontinuities in Precambrian basements (Titley, 1978); the trend of Cretaceous Laramide-aged

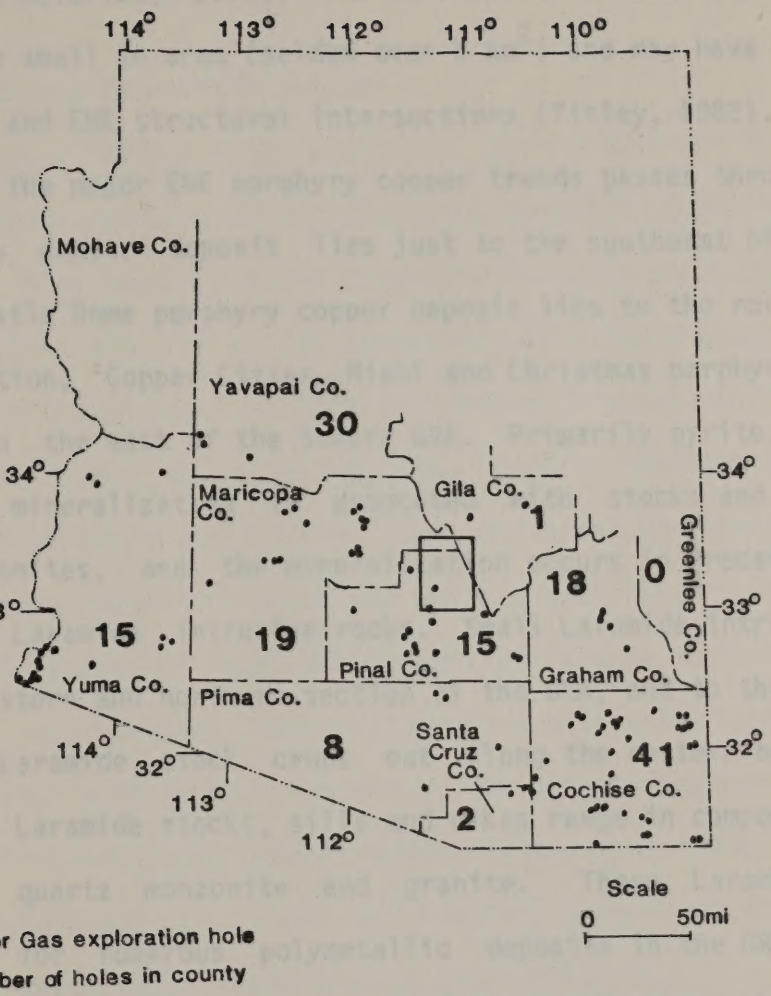

FIG.6. LOCATION OF OIL AND GAS EXPLORATION HOLES IN SOUTHERN ARIZONA, after Jones (1979).

uplifts and faults (Neilsen, 1979; Davis, 1981); the Texas zone of Schimtt (1966); and the trend of the Laramide magmatic arcs. The ENE-trend is sub-parallel to Precambrian fold axes and to Laramide tensional fractures (Rehrig and Heidrick, 1976). The intrusions related to the porphyry copper deposits are small in area (seldom over 3 km^2) and may have been emplaced along the NW and ENE structural intersections (Titley, 1982).

One of the major ENE porphyry copper trends passes through the GRA. The Ray porphyry copper deposit lies just to the southeast of the White Canyon WSA, the Castle Dome porphyry copper deposit lies to the north of the WSA and the Inspiration, Copper Cities, Miami and Christmas porphyry copper deposits lie just to the east of the Sonora GRA. Primarily pyrite, chalcopyrite and molybdenite mineralization is assocated with stocks and dikes of Laramide quartz monzonites, and the mineralization occurs in Precambrian schists and within the Laramide intrusive rocks. Small Laramide intrusions crop out in the northeastern and northern section of the GRA, and to the east of the WSA. One small Laramide stock crops out along the eastern border of the WSA. These small Laramide stocks, sills and dikes range in composition from quartz diorite to quartz monzonite and granite. These Laramide intrusions are responsible for numerous polymetallic deposits in the GRA and near the WSA (including Cu 141, which crops out in the northeastern corner of the WSA). Mineralization occurs or is hosted in Precambrian schists, granites, diabase and sedimentary rocks; and Cambrian to Pennsylvanian quartzites, sandstones, shales and limestones (Steele, 1978). These Laramide intrusion-related deposits commonly contain copper, either as disseminated or vein type deposits, and supergene enrichment is very common. Tungsten, molybdenum, silver, gold, zinc, lead and manganese are present as hydrothermal deposits; these deposits are common in Pinal Schist, diabase and limestone. Laramide intrusions in Precambrian diabase rarely contain vanadium (site Cu 2 and Ag

uplifts and faults (Hutton, 1979; Davis, 1981); the Texas zone of Zoback (1992); and the trend of the Laramide magmatic arcs. The ENE-trend is sub-parallel to Precambrian fold axes and to Laramide tectonic fractures (Hardy and Holdredge, 1976). The intrusions related to the porphyry copper deposits are small in area (seldom over 3 km^2) and may have been emplaced along the NW and ENE structural intersections (Titley, 1982).

One of the major ENE porphyry copper trends passes through the USA. The Ray porphyry copper deposit lies just to the southeast of the White Canyon WSA, the Castle Dome porphyry copper deposit lies to the north of the WSA and the Inspiration, Copper Cities, Miami and Christmas porphyry copper deposits lie just to the east of the Sierra USA. Primarily mafic, chalcopyrite and molybdenite mineralization is associated with stocks and dikes of Laramide quartz monzonites, and the mineralization occurs in Precambrian schists and within the Laramide intrusive rocks. Small Laramide intrusions crop out in the Mineral Creek and Pertrified Section of the USA, and to the east of the USA. One small Laramide stock crops out along the eastern border of the USA. These small Laramide stocks, sills and dikes range in composition from quartz diorite to quartz monzonite and granite. These Laramide intrusions are responsible for numerous polymetallic deposits in the USA and near the USA (including Cu 181, which crops out in the northeastern corner of the USA). Mineralization occurs or is hosted in Precambrian schists, granites, diabase and sedimentary rocks, and Cambrian to Pennsylvanian quartzites, sandstones, shales and limestones (Schafer, 1971). Those Laramide intrusion-related deposits commonly contain copper, either as disseminated or vein type deposits, and sometimes molybdenite is many common. Tungsten, molybdenum, silver, gold, zinc, lead and manganese are present as secondary deposits; these deposits are common in Pinal Schist, diabase and limestone. Laramide intrusions in Precambrian diabase rarely contain vanadium (site Cu 2 and Ag

33) or arsenic, antimony and selenium (site Cu 26). Uranium anomalies have been reported in the Pinal Schist related to Laramide intrusives (Cu 3, U183, and U 187), and two occurrences are present contained within Laramide Schultze Granite (U185 and U186).

Mid-Tertiary Basin-Fill Sediments

Mid-Tertiary valley-fill sediments are widespread in southwestern and southern Arizona and, since the discovery of the Anderson Mine (Sherborne et al., 1979), have become a prime target for uranium exploration. In order to form a uranium deposit by the agency of circulating groundwater or connate water, it is necessary to have an adequate uranium source rock, permeable sediments for water to flow through, and a reductant to precipitate the uranium. Mid-Tertiary sediments crop out in the northeastern corner of the GRA, and in the southern end of the White Canyon WSA, as well as just to the east and southwest of the WSA. Suitable source rocks may be Precambrian granites or mid-Tertiary volcanics which are interbedded with conglomeratic sections. The interbedded sediments are suitably permeable, but it is not known where reductants are present; the depositional environment was relatively high energy. Past or present geothermal waters may have been sufficiently reducing to cause uranium precipitation.

The lower section of Whitetail Conglomerate consists of predominantly monolithic fragments. In the area on the southeast edge of the White Canyon WSA and extending into the WSA, this lower section consists of eroded, oxidized leach capping of Pinal Schist, which was subsequently oxidized and leached, containing oxide and secondary sulfide copper minerals, along with abundant iron oxides. In areas were limestone was also eroded, the copper solutions reacted with the limestone fragments to form exotic copper mineralization, which occurs as fragment and matrix replacement. Site AuCu 143 has been actively mined and contains copper mineralization in the

331 or arsenic, antimony and selenium (site Cu 20). Uranium anomalies have been reported in the Pinal Schist related to Laramide intrusives (Cu 3, U123, and U 1271), and two occurrences are present contained within Laramide Schultze Granite (U185 and U185).

Mid-Tertiary Basin-Fill Sediments

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The Tertiary section of Whitetail Conglomerate consists of predominantly monolithic fragments. In the area on the southeast edge of the White Canyon WSA and extending into the WSA, this lower section consists of eroded, oxidized lava, capping at Pinal Schist, which was subsequently weathered and leached, contributing, minor and secondary sulfide copper minerals, along with abundant iron oxides. In areas where intrusives was also eroded, the copper solutions reacted with the limestone fragments to form cupric copper mineralization, which occurs as fragments and massive replacement. Site Ad7 has been actively mined and exhibits copper mineralization in the

Whitetail Conglomerate. This deposit is within a mile of the WSA, and copper-bearing Whitetail Conglomerate probably extends into the WSA. Site Cu 177 is also a deposit in Whitetail Conglomerate that consists of eroded leach cappings of Pinal Schist.

Mid-Tertiary Volcanic Rocks

Mid-Tertiary volcanics in southern Arizona, southwestern New Mexico and Mexico are associated with gold-silver and base metal lode deposits (Damon et al., 1981; Clark et al., 1982). The volcanics were erupted when the magmatic arc swept rather rapidly westward, possibly as a result of the steepening of the Benioff zone (Coney and Reynolds, 1977). In southwestern New Mexico the deposits are associated with cauldrons from which voluminous ignimbrites and other volcanics were erupted (Elston, 1978). Caulderas may exist in the Superior-Superstition volcanic field (Shafiqullah et al., 1980) northwest of the Sonora GRA. The volcanic field extends into the northwest quarter of the GRA, and a small stock, possibly a plug or remnant of a cauldera, crops out north of the White Canyon WSA at Reevis Canyon (Woodcamp Canyon stock). There are five base metal gold-silver deposits within the mid-Tertiary volcanic rocks (Cu 36, Cu 45, AgAu 97, Ag 122, Ag 144). The siliceous Tertiary volcanics that contain base metal and silver-gold deposits crop out through the north-central region of the WSA, but there are no known deposits of this type within the WSA. One mercury occurence (Hg 96) is present within the Tertiary volcanics in the northwestern part of the GRA. In the Sonora GRA there are thirteen manganese occurrences that are within or near mid-Tertiary volcanics or intrusives. Hewett and Fleischer (1960), in a regional study of manganese oxide vein deposits, concluded that most were formed from hydrothermal fluids associated with late stages of volcanic activity; it is likely that these deposits are of a similar nature. No

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production is recorded from any of the occurrences. There are four perlite occurrences within the mid-Tertiary silicic volcanics, and one of these (pe 178) produces perlite for building stone. Two bentonite occurrences are reported within the GRA, both have no recorded production.

Late Tertiary Basin-Fill Sediments

Late Tertiary sediments are present in all basins formed as a result of Basin and Range faulting. They crop out in the north central, northeast and southeast sections of the GRA. The depths of these basins are indicated by contours shown in figure 1, which are interpreted by Oppenheimer and Sumner (1981) from gravity data. As in the case of the mid-Tertiary sediments, adequate uranium source rocks and permeable horizons are present. Extensive organic reductants are not known to be present in these sediments, but the warm geothermal waters found in wells east of Superior (see figure 3) may indicate the presence of deeper geothermal waters that may be sufficiently reducing to cause precipitation of uranium.

Silicic tuff beds within these late Tertiary sediments contain three producing perlite deposits, and one producing marekanite (Apache tears) deposit. These late Tertiary sediments do not crop out within the White Canyon WSA.

Recent Alluvium

Alluvium formed in present-day river valleys is a possible site for concentrations of placer gold. Two placer districts are present within the GRA: the Globe-Miami district placers lie in the northeast corner of the GRA; the Mineral Creek District lies in the east central region, northeast of the WSA. Two individual placers lie to the southeast of the WSA, one (Au 22) has produced a small amount of gold.

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Alluvium formed in present-day river valleys is a possible site for concentrations of placer gold. Two placer districts are present within the GRA: the Dixie-Mount District placers lie in the northeast corner of the GRA; the Mineral Creek District lies in the east central region, northeast of the VCA. Two individual placers lie in the southwest of the WCA, one (Au 22) has produced a small amount of gold.

Geothermal

Extensive but low temperature geothermal resources are known to be present in southern Arizona (Jones, 1979). Factors that are favorable for the existence of substantial geothermal systems are: Presence of a high temperature heat source; presence of aquifers which allow large volumes of water to circulate through the hot rocks; and the presence of cap rocks which prevent the escape to the surface of at least some of the hot fluid.

In southern Arizona the intensity of volcanic activity has been waning during the past 9 m.y. and that may explain why most geothermal areas are at a low temperature. Aquifers and cap rocks are present within the late Tertiary valley-fill sediments. In the Sonora GRA, two warm water wells are present in the small basin just east of Superior, north of the WSA, with well depths of 1408 meters (temperature 53°C) and 1808 meters (temperature 72°C) for Gt 174 and 175, respectively. A third well is present on the side of the basin in the southeast corner of the GRA (Gt 176), with a well depth of 590 meters and a temperature of 39°C.

Mineral Economics

The assessment of the geological, energy and mineral resources favorability should rely upon not only geology, but must also be concerned with economic factors and priorities. Discovery, recovery, cost of production of the resource from sources with varying qualities and/or concentrations are included in those considerations. Special consideration must be given to the strategic and critical minerals and metals. As this project is of limited scope, and because of special difficulties in southern Arizona, economic analyses of various commodities can only be discussed briefly.

Some factors especially important to the evaluation of the mineral and

Geothermal

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In southern Arizona the intensity of volcanic activity has been waning during the past 2 m.y. and that may explain why most geothermal areas are of a low temperature. Aquifers and cap rocks are present within the late Tertiary valley-fill sediments. In the Sonoma ERA, two warm water wells are present in the small basin just east of Superior, north of the ERA, with well depths of 1400' meters (temperature 53°C) and 1220' meters (temperature 72°C) for Gc 124 and 125, respectively. A third well is present on the side of the basin, in the southwest corner of the ERA lot 126, with a well depth of 590 meters and a temperature of 39°C.

Mineral Economics

The assessment of the geological, energy and mineral resources favorability should fully weigh not only geology, but also be concerned with economic factors and priorities. Discovery, recovery, cost of production of the resource from sources with varying qualities and/or concentrations are included in these considerations. Special consideration must be given to the strategic and critical minerals and metals. As this project is of limited scope, and because of special difficulties in southern Arizona, economic analyses of various commodities can only be discussed briefly.

Some factors especially important to the evaluation of the mineral and

energy resources of southwestern Arizona include the following:

1. The geology of the Sonora GRA is very complex and detailed information on the geology and mineral deposits of the WSA is somewhat limited. This is multiplied by recent and ongoing reinterpretations of the geology of the Basin and Range in Arizona. In order to interpret the geology of the WSA, and thus be able to project the types of mineral deposits that may be present in the area, it is necessary to apply information about known areas of apparently similar geology to the interpretation of the geology of the WSA. These are not optimum conditions. A wide variety of possibilities must be considered, and therefore, discussions of mineral economics must be considered tentative.
2. Contributing to the problems listed above, and creating some other distinct difficulties, are the ruggedness and roadless nature of the WSA. Roadlessness, a criterion for WSAs, inhibits exploration and development of mineral resources due to poor access, distance to market, and other factors which increase the expense and difficulty of geological and mineral exploration.
3. A great number of commodities, including strategic and critical minerals and metals, are known to occur near the WSA, and may also occur inside the WSA.
4. Considering all the above mentioned problems, it is very possible that sophisticated methods currently used by professional geologic explorationists have not been fully employed in southern Arizona. Most of the mines and occurrences in the GRA were discovered many years ago by

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2. Contributing to the problems listed above, and creating some other distinct difficulties, are the ruggedness and roadless nature of the WSA. Roadlessness, a criterion for WSAs, inhibits exploration and development of mineral resources due to poor access, distance to markets, and other factors which increase the expense and difficulty of geological and mineral exploration.

3. A great number of commodities, including strategic and critical minerals and metals, are known to occur near the WSA, and may also occur inside the WSA.

4. Considering all the above mentioned problems, it is very possible, that exploration methods currently used by prospectors and geologic explorationists have not been fully employed in southern Arizona. Most of the mines and occurrences in the GSA were discovered many years ago by

prospectors using simple techniques.

The White Canyon WSA is host to one reported copper occurrence (Cu 141) of unknown origin. It occurs near the contact between Laramide quartz monzonite and Precambrian Pinal Schist, and may represent a portion of a porphyry copper deposit.

There has been much recent speculation about the potential for oil and gas occurrences in the Basin and Range of southern Arizona. It has been suggested that the Overthrust Belt, related to oil occurrences from Canada to Utah, extends into Arizona as a wide NW-SE trending belt curling around the Colorado Plateau in the Basin and Range area (Peirce, 1982; Anschutz, 1980). The theory states that around 60 m.y.B.P. older crystalline rocks thrust over younger, possibly oil-rich, strata (Peirce, 1982). The complex structures, including Basin and Range Faults, found in southern Arizona coupled with the high tempratures created by igneous activity since that time dim the possibility of preservation of oil and, as Peirce (1982) states, if the Overthrust Belt exists, or ever has existed, in Arizona, geologic complexity obscures it and drilling has not yet resolved the issue. Anschutz (1980) suggests that the Overthrust Belt could become the most important oil and gas province to be discovered in the last 20 to 30 years, but also states that it is one of the most difficult and expensive areas to explore and develop.

Strategic and Critical Minerals and Metals

Within the White Canyon WSA there is one reported occurrence of copper. Near the WSA are occurrences and deposits of the strategic and critical metals copper, silver, manganese, lead, zinc and molybdenum. Tungsten has been produced within the GRA, but there are no deposits near the WSA.

Zinc has a variety of industrial applications, the most important being zinc-base alloy die castings, galvanizing iron and steel products, and brass

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Strategic and Critical Minerals and Metals

Within the White Canyon USA there is one reported occurrence of copper. Near the USA are occurrences and deposits of the strategic and critical metals copper, silver, manganese, lead, zinc and molybdenum. Tungsten has been produced within the USA, but there are no deposits near the USA.

Zinc has a variety of industrial applications, the most important being zinc-base alloy die castings, galvanizing iron and steel products, and brass

production. Much of the lead used in the United States is consumed in the manufacture of storage batteries and as a gasoline additive, although use in gasoline is declining. Use in ammunition and solder is also important, increasingly so during wartime. More silver is consumed in photography in the United States in one year than this country produces during that time (Brobst and Pratt, 1973). Copper, although considered a strategic and critical metal, occurs in abundance in Arizona. Manganese is abundant elsewhere in the world, but is rare in the United States. It is critical to the steel industry and the chemical industry. Molybdenum is not rare in the United States, but is necessary to the steel industry.

In summary, it must be noted that the Sonora GRA contains a large number of mineral occurrences and many different commodities. Deposits of strategic and critical commodities, some which have produced, are known to occur in the area around the WSA. Further exploration could lead to the discovery of potentially important deposits in the GRA and WSA.

THE GEOLOGY, ENERGY AND MINERAL RESOURCES OF THE WHITE CANYON WILDERNESS STUDY AREA

In this section the WSA is discussed with respect to its physiography, geology, mineral occurrences, resource potential, and recommendations for further work. Detailed and specific information in some areas is lacking, and will be summarized from the preceding sections. The classification of resource potential and level of confidence is according to the scheme provided by the Bureau of Land Management (attachment 9, dated March 24, 1982). The classification is summarized on the maps in figures 7 through 9 and detailed below.

Classification Scheme

1. The geologic environment and the inferred geologic processes do

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Classification Scheme

1. The geologic conditions and the indicated geologic processes as

not indicate favorability for accumulation of mineral resources.

2. The geologic environment and the inferred geologic processes indicate low favorability for accumulation of mineral resources.
3. The geologic environment, the inferred geologic processes, and the reported mineral occurrences indicate moderate favorability for accumulation of mineral resources.
4. The geologic environment, the inferred geologic processes, the reported mineral occurrences, and the known mines or deposits indicate high favorability for accumulation of mineral resources.

Level of Confidence Scheme

A. The available data are either insufficient and/or cannot be considered as direct evidence to support or refute the possible existence of mineral resources within the respective area.

B. The available data provide indirect evidence to support or refute the possible existence of mineral resources.

C. The available data provide direct evidence but are quantitatively minimal to support or refute the possible existence of mineral resources.

D. The available data provide abundant direct and indirect evidence to support or refute the possible existence of mineral resources.

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D. The available data provide abundant direct and indirect evidence to support or refute the possible existence of mineral resources.

Physiography

The White Canyon WSA (020-187) is dominated by the White Canyon in the central portion of the WSA; the canyon walls rise steeply to the northeast and southwest to 4000 feet. The relief in the WSA is aproximately 2000 feet, the lowest elevation being at the southern end, just north of the Gila River.

Geology

The WSA is underlain by Precambrian Pinal Schist and the Ruin (or Oracle) Granite, which was probably emplaced between 1400 and 1450 m.y.B.P. The contact between these two units is now buried beneath Tertiary basin-fill. Younger Precambrian diabase crops out in the northeasternmost corner. Paleozoic rocks crop out in the northern end of the WSA and may continue southward underneath the Tertiary cover. Laramide quartz monzonite crops out along the eastern border of the WSA, where it intrudes the Pinal Schist. Whitetail Conglomerate crops out in the southern third of the WSA, and in the eastern edge, where it consists of the lower, monolithic conglomerate unit, composed primarily of eroded, mineralized Pinal Schist. In the southern end, it is probably composed of Ruin (or Oracle) Granite. The Whitetail Conglomerate is overlain by the mid-Tertiary Apache Leap tuff. Mid-Tertiary intrusives crop out in the southwesternmost corner of the WSA.

Mineral Deposits

There is one copper occurrence reported within the WSA boundary. However, similar geologic environments elsewhere in the GRA contain mineral occurrences of the following types:

a) Copper sulfide and oxide mineralization in clasts of leached cap rock of Pinal Schist, now forming the basal unit of Whitetail Conglomerate overlying Pinal Schist. The eastern

Physiography

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There is one copper occurrence reported within the WSA boundary. However, similar geologic environments elsewhere in the WSA contain mineral occurrences of the following types:

a) Copper sulfide and oxide mineralization in clasts of leached cap rock of Pinal Schist, now forming the basal unit of Whitetail Conglomerate overlying Pinal Schist. The eastern

part of the WSA contains Whitetail deposited on mineralized Pinal Schist. The Whitetail may continue westward underlying the Tertiary volcanics.

b) Vein and disseminated precious and base metal mineralization associated with quartz monzonite. The Laramide Granite Mountain Porphyry quartz monzonite crops out along the eastern boundary of the WSA. Potential host rocks for mineralization include the Pinal Schist in the northeastern part of the WSA; Oracle Granite in the southern part of the WSA; and Precambrian and Paleozoic sediments which crop out just north of the WSA and may extend southward through the WSA underneath the Tertiary cover.

c) Veins and disseminated base and precious metal deposits associated with mid-Tertiary rhyolitic intrusives. These rocks crop out in a broad zone through the middle of the WSA.

d) Hydrothermal vein deposits of manganese associated with late stages of mid-Tertiary volcanic or shallow plutonic activity. The central region of the WSA contains mid-Tertiary volcanics; the southwestern part of the WSA contains mid-Tertiary intrusives.

e) Uranium deposition in mid-Tertiary sediments or volcanics. Source rocks are present within the WSA (Precambrian granite and mid-Tertiary felsic volcanics), but reductants are not known.

f) Uranium deposition in Precambrian granite intruded by mid-Tertiary dikes. Felsic dikes intruding the Oracle Granite concentrate uranium. Mid-Tertiary intrusives crop out in the southwest part of the WSA, and just south of the WSA they

part of the WSA contains whitetail deposited on mineralized Final Schist. The Whitetail may continue westward underlying the Tertiary volcanics.

b) Base and disseminated precious and base metal mineralization associated with quartz monzonite. The Laramide Granite Mountain Porphyry quartz monzonite crops out along the eastern boundary of the WSA. Potential host rocks for mineralization include the Final Schist in the northeastern part of the WSA; Precambrian Granite in the southern part of the WSA; and Precambrian and Paleozoic sediments which crop out just north of the WSA and may extend southward through the WSA underneath the Tertiary cover.

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f) Uranium deposition in Precambrian granite intruded by mid-Tertiary dikes. Felsic dikes intruding the Oracle Granite contain uranium. Mid-Tertiary intrusives crop out in the southwest part of the WSA, and just south of the WSA they

intrude Precambrian granite.

g) Uranium potential in the Dripping Spring quartzite gray unit, in particular, where intruded by Precambrian diabase. The Dripping Spring Quartzite and Precambrian diabase crop out north of the WSA. The quartzite may extend southward into the WSA underneath Tertiary cover, but the extent of the diabase is unknown.

h) Perlite from mid-Tertiary felsic volcanic rocks. As stated previously, these rocks crop out throughout the central region of the WSA. North of the WSA in the Superior region, perlite is actively being mined.

Land Classification for GEM Resources Potential

Metallic Minerals

The area around deposit AgCu 143 (area 1; fig. 7) is classified as highly favorable at a confidence level of D. The reason for this classification is that copper and silver mineralization is prevalent in the area around the Copper Butte Mine, which has produced up to 200,000 tons of 3-3.5% Cu up to 1968. The property is not currently producing but is being worked on by Kennecott.

Area 2 (fig. 7) is classified as highly favorable at a confidence level of D. The area contains the Ray porphyry copper deposit, which was actively mined until May of 1982, when depressed copper prices forced a curtailment of mining activity.

Area 3 (fig. 7) is classified as being moderately favorable with a confidence level of C. This is the area of the Whitetail Conglomerate (Tms in fig. 3) which contains much mineralized cobbles of porphyry copper Pinal

intrude Precambrian granite.

g) Granitic pegmatites in the Dripping Springs quartzite grey unit, in particular, where intruded by Precambrian diabase. The Dripping Springs Quartzite and Precambrian diabase crop out north of the WSA. The quartzite may extend southward into the WSA underneath Tertiary cover, but the extent of the diabase is unknown.

h) Perlite from mid-Tertiary felsic volcanic rocks. As stated previously, these rocks crop out throughout the central region of the WSA. North of the WSA in the Superior region, perlite is actively being mined.

Land Classification for BLM Resources Potential

Metallic Minerals

The area around Oracle Ridge (area 1, Fig. 7) is classified as highly favorable at a confidence level of D. The reason for this classification is that copper and silver mineralization is prevalent in the area around the Copper Basin Mine, which has produced up to 200,000 tons of 2-3.5% Cu up to 1968. The property is not currently producing but is being worked on by Kennecott.

Area 2 (Fig. 7) is classified as highly favorable at a confidence level of D. The area contains the Dry Pennsylvania copper deposit, which was actively mined until May of 1982, when depressed copper prices forced a curtailment of mining activity.

Area 3 (Fig. 7) is classified as being moderately favorable with a confidence level of E. This is the area of the Mineral Complex (Fig. 8) which contains much mineralized cobbles of Pennsylvania copper Pinal

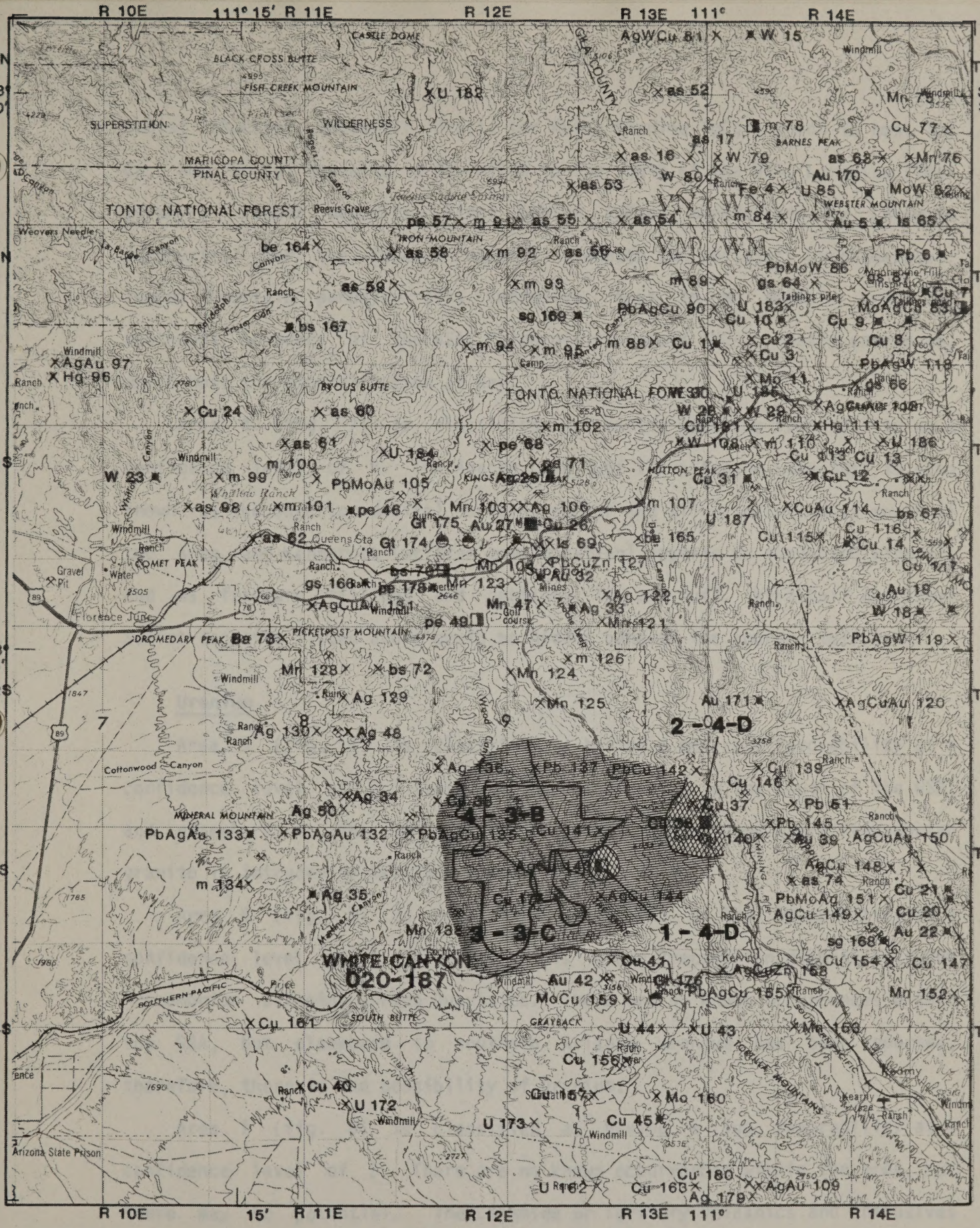

FIG. 7 FAVORABILITY AND LEVEL OF CONFIDENCE MAP FOR METALLIC MINERAL RESOURCES OF THE SONORA AREA, ARIZONA

Schist (Buckeye deposit); Oracle (or Ruin) Granite (pCgr) which is host for Cu, Au, Mo-Cu deposits a few miles to the south of the WSA; Laramide (TKg) porphyry copper deposits; Pinal Schist (pCsc) mineralized by Laramide porphyries near the Buckeye deposit (beneath the Whitetail Conglomerate); Teapot Mountain porphyry (Ti) intrusive, host to Mn deposit near the southwest boundary of the WSA; Paleozoic sediments (MDs), mostly carbonate, which host the mineralization at Ray.

Area 4 (fig. 7) is classified as having moderate favorability at a confidence level of B. The Apache Leap tuff (Tvs; Apache Leap tuff is also known as the Superior dacite) contains copper and silver occurrences north of the area, and Kennecott (written communication) reports Cu replacing minerals and as fracture fillings and coatings in the tuff. Whitetail and Pinal Schist deposits listed above could be hidden beneath the younger tuff unit.

Uranium

Area 5 (fig. 8) is classified as having a moderate favorability at a confidence level of B. There are four occurrences to the south of the WSA, and elsewhere in the GRA uranium occurrences are found where Precambrian granite is intruded by Tertiary dikes.

Area 6 (fig. 8) is classified as having a low favorability at a confidence level of C. This area is where Precambrian diabase intrudes Precambrian Dripping Spring Quartzite. There are no known occurrences within the GRA, but elsewhere in southern Arizona uranium has been reported, therefore, there is the possibility of uranium.

Area 7 (fig. 8) is classified as having a low favorability at a confidence level of B. There are no known occurrences within the area, but there may be potential. The Laramide or Tertiary volcanics and intrusives are potential source rocks, the question is the presence of reductants.

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Area 5 (Fig. 8) is classified as having a moderate favorability at a confidence level of B. There are four occurrences in the south of the WSA, and elsewhere in the CGA uranium occurrences are found where Precambrian granite is intruded by Tertiary dikes.

Area 6 (Fig. 8) is classified as having a low favorability at a confidence level of C. This area is where Precambrian diabase intrudes Precambrian Pinal Schist and Oracle Granite. There are no known occurrences within the CGA, but elsewhere in southern Arizona uranium has been reported. Therefore, there is the possibility of uranium.

Area 7 (Fig. 8) is classified as having a low favorability at a confidence level of C. There are no known occurrences within the area, but there may be potential. The Laramide or Tertiary volcanics and intrusives are potential source rocks. The question is the presence of reductants.

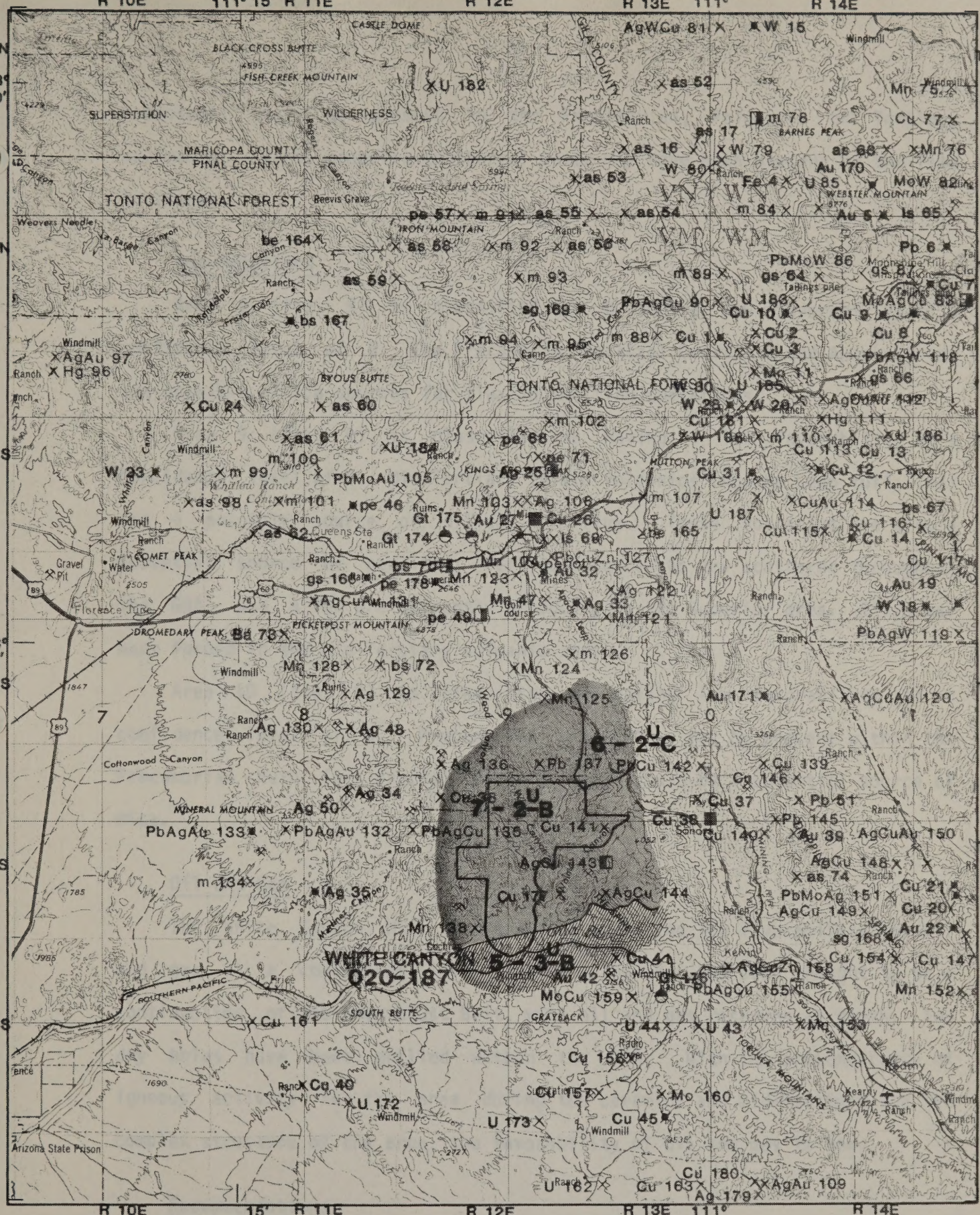

FIG.8 FAVORABILITY AND LEVEL OF CONFIDENCE MAP FOR URANIUM RESOURCES OF THE SONORA AREA, ARIZONA

Reductants may be present in the Precambrian, Paleozoic or Tertiary sediments. Warm, reducing geothermal water may have been present in the late Tertiary.

Non-Metallics

Area 8 (fig. 9) is classified as having a low favorability at a confidence level of B. The Precambrian Mazatzal Quartzite and Apache group are possible silica sources for flux in smelting operations.

Area 9 (fig. 9) is classified as having a low favorability at a confidence level of B. Mid-Tertiary felsic volcanics (Apache Leap tuff; Tvs) are a possible source of silica for flux. These volcanics are also a potential source of perlite. Perlite occurrences are scattered throughout the GRA, and a few are currently producing in the Superior area. Clays may have formed in the mid-Tertiary volcanic rocks.

Area 10 (fig. 9) is classified as having low favorability at a confidence level of B. Precambrian pegmatites may be present within the Precambrian Ruin (or Oracle) Granite, and could be a potential source of mica.

Oil and Gas

The White Canyon WSA is classified as having low favorability for oil and gas at a confidence level of B. The area has been thought to be a continuation of the Overthrust Belt, with oil and gas reserves at depth. Two dry holes have been drilled within the GRA. With the preponderance of igneous activity in the area during the Laramide and mid-Tertiary and the complex structure of the area, the favorability of oil and gas is low.

Recommendations

For area 1 it is recommended that:

Reductants may be present in the Precambrian, Paleozoic, or Tertiary sediments. Here, reducing geothermal water may have been present in the late Tertiary.

Non-Metallics

Area 8 (Fig. 9) is classified as having a low favorability at a confidence level of 8. The Precambrian Mazatzal Quartzite and Apache group are possible silica sources for flux in smelting operations.

Area 9 (Fig. 9) is classified as having a low favorability at a confidence level of 8. Mid-Tertiary felsic volcanics (Apache Leap tuff; Tvs) are a possible source of silica for flux. These volcanics are also a potential source of perlite. Perlite occurrences are scattered throughout the GRA, and a few are currently producing in the superior area. Clays may have formed in the mid-Tertiary volcanic rocks.

Area 10 (Fig. 9) is classified as having low favorability at a confidence level of 8. Precambrian pegmatites may be present within the Precambrian Ruin (or Oracle) Granite, and could be a potential source of mica.

Oil and Gas

The White Canyon Area (Fig. 9) is classified as having low favorability for oil and gas at a confidence level of 8. The area has been thought to be a continuation of the Uinta Basin, which oil and gas reserves at depth. Two dry holes have been drilled within the GRA. With the proximity of igneous activity in the area during the Laramide and mid-Tertiary and the complex structures of the area, the favorability of oil and gas is low.

Recommendations

For area 1 it is recommended that:

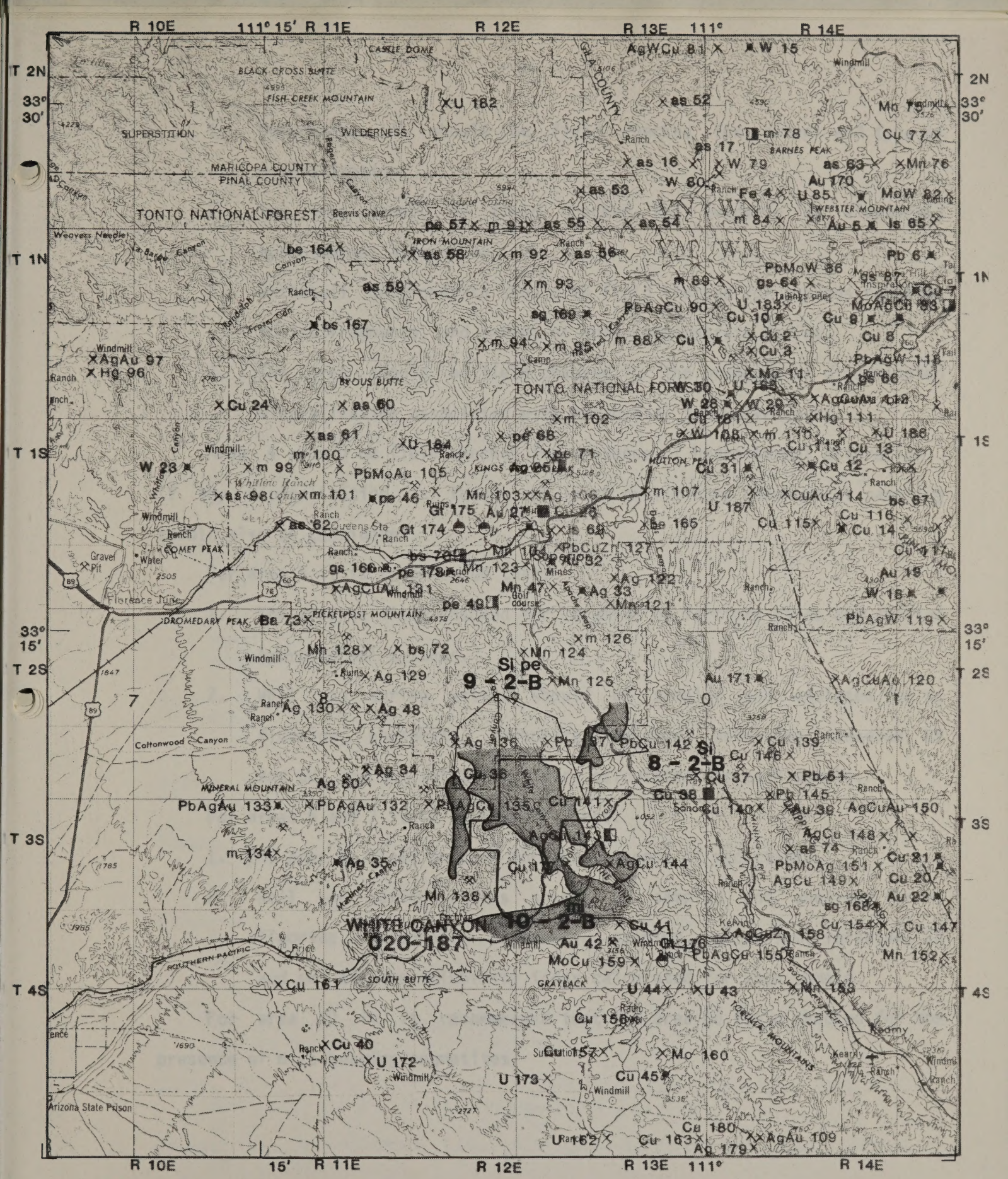

FIG.9 FAVORABILITY AND LEVEL OF CONFIDENCE MAP FOR NON-METALLIC MINERAL RESOURCES OF THE SONORA AREA, ARIZONA

1. Occurrence 141 should be field checked for extent and type of mineralization.
2. The area should be field checked for evidence of widespread hydrothermal alteration.
3. Whitetail Conglomerate should be field checked for cuprous hematite schist fragments, and extent of this conglomerate facies.
4. The area should be field checked for the presence of disseminated mineralization associated with hypabyssal intrusive rocks.

Area 4 should be field checked for evidence of hydrothermal alteration. If any mineralization is found, at least preliminary geochemical sampling should also be considered.

For area 5 it is recommended that:

1. The area be field checked for Laramide or Tertiary dikes and related hydrothermal systems.
2. Well and spring waters should be sampled and analyzed for U, fluoride, phosphate, carbonate, calcium, potassium, vanadium, Eh and pH, and the solubility index calculated for each sample.

For areas 6 and 7 it is recommended that:

1. The area be field checked for the presence of reductants.
2. Well and spring waters should be sampled and analyzed for U, fluoride, phosphate, carbonate, calcium, potassium, vanadium, Eh and pH, and the solubility index calculated for each sample.

For area 10 it is recommended that the area be field checked for the presence of mica-bearing pegmatites.

1. Occurrence (A) should be field checked for extent and type of mineralization.
2. The area should be field checked for evidence of widespread hydrothermal alteration.
3. Whitesail Conglomerate should be field checked for curious hematite schist fragments, and extent of this conglomerate facies.
4. The area should be field checked for the presence of disseminated mineralization associated with hypabyssal intrusive rocks.

Area 4 should be field checked for evidence of hydrothermal alteration. If any mineralization is found, at least preliminary geochemical sampling should also be considered.

For Area 5 it is recommended that:

1. The area be field checked for Laramide or Tertiary dikes and related hydrothermal systems.
2. Well and spring waters should be sampled and analyzed for B, fluoride, sulphate, carbonate, calcium, potassium, vanadium, Eh and pH, and the solubility index calculated for each sample.

For areas 6 and 7 it is recommended that:

1. The area be field checked for the presence of reductants.
2. Well and spring waters should be sampled and analyzed for B, fluoride, sulphate, carbonate, calcium, potassium, vanadium, Eh and pH, and the solubility index calculated for each sample.

For area 10 it is recommended that the area be field checked for the presence of mica-bearing pegmatites.

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